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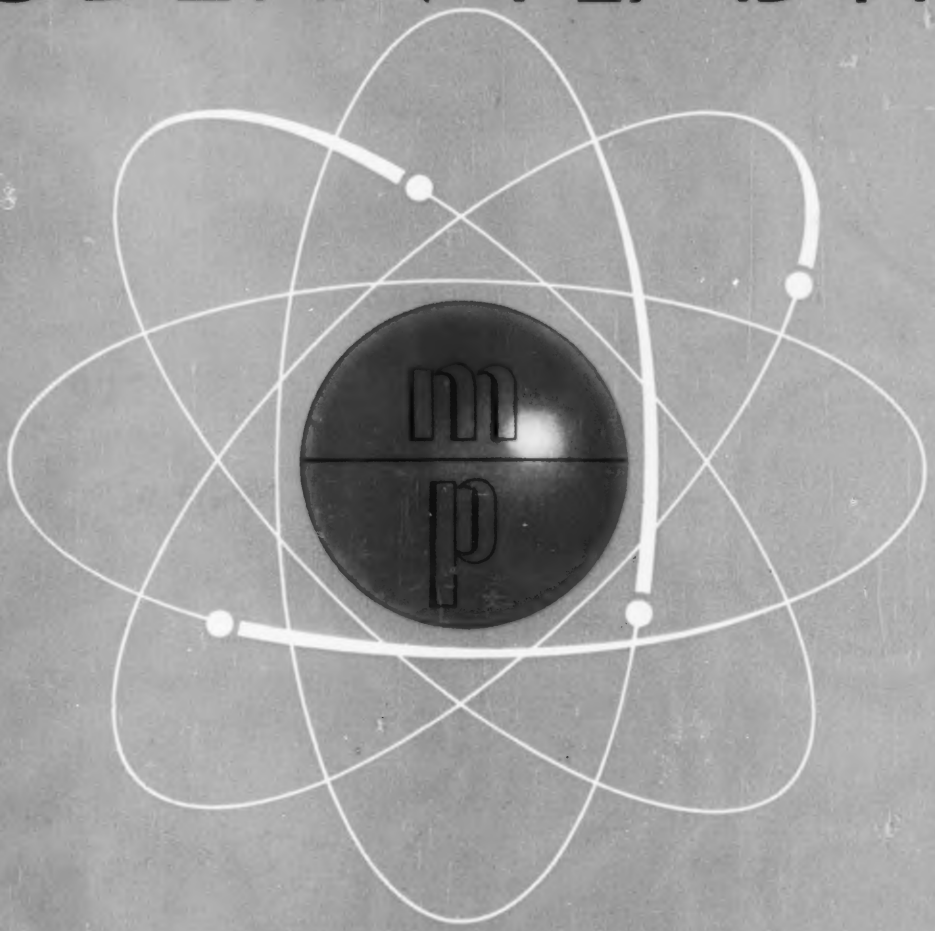

MARCH 1955

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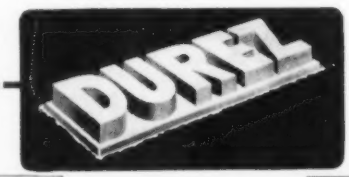

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MODERN PLASTICS*

March 1955 • Vol. 32 No. 7

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Modern Plastics, published monthly by Breskin Publications, Inc., at Emmett St., Bristol, Conn. Modern Plastics Encyclopedia Issue published as second issue in September by Plastics Catalogue Corp., at Emmett St., Bristol, Conn. Executive and Editorial Office: 575 Madison Ave., New York 22, N. Y. Entered as second class matter at the Post Office at Bristol, Conn., December 14, 1950, under the Act of March 3, 1879. Modern Plastics is regularly indexed in Industrial Arts Index and Industex. Subscription rates: U.S., its possessions, and Canada, $6.00 for one year, $11.00 for two years, $15.00 for three years; Pan-American countries, $8.00 for one year, $13.00 for two years, $17.00 for three years; all other countries $12.00 for one year, $20.00 for two years, $28.00 for three years, payable in U.S. currency. Single copies $0.75 each in the United States, its possessions, and Canada; all other countries, $1.25 (except the September Encyclopedia Issue, which is not sold separately). Printed in the U.S.A., by Hildreth Press, Inc., Bristol, Conn.
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EDITORIAL

Toys Had Better Be Better

With the 1955 Toy Fair only a few days away, it is vital that all companies in the plastics industry concerned with the vast toy market give thought to some sobering facts.

The child population (ages 1 to 14) in the United States grew from 35.9 million in 1945 to 47.1 million in 1954. By 1960 there will be 51.9 million children in this age group.

This growth, coupled with recognized increases in disposable family income, have increased the total toy market from $450 million at retail in 1945 to over a billion dollars in 1954.

Up until 1953 plastics' share of this market constantly increased, and increased in greater proportion than the share of other materials.

But something happened in 1954. The volume of plastics which went into toys suffered a loss of at least 5% and probably more in comparison to the 1953 volume.

In an expanding market an industry has to gain in volume merely to hold its own. A loss such as that described above represents a long backward step!

Where and how was the damage done that resulted in this loss? The picture becomes fairly clear when viewed in context with an age group analysis of the child population at the present time:

Children under 5 years of age	17.7 million
Children from 5 to 9 years of age	16.4 million
Children from 10 to 14 years of age	13.0 million
Total Child Population	47.1 million

In our opinion the damage was done in the biggest age group: toys for children under 5. Here are sold the low-priced toys, from 19¢ to $1.98. Here are sold the "impulse purchase" toys. And here were offered most of the poor-quality, badly engineered, thin-walled, weak toys.

Sales of unsatisfactory plastics toys in this under-five market establish in the minds of mothers a bad opinion about all plastics toys, which is bound to be reflected in future sales of higher-quality, higher-priced toys to the older age groups.

There is vast evidence of a continuing improvement in plastics toys for children 5 to 14 years of age, but sales of these toys suffer because of damage done to mothers' opinions when the children were in the infant classification.

The answer to this problem lies not in promotion alone. Neither does it lie in any single selection of a plastic material for toy manufacture. It lies in a new ethical approach on the part of manufacturers of toys for the under-five age group, possibly in new concepts of toy design, and certainly in a careful consideration of materials and engineering factors in low-priced toys for infants.

We hope that the approaching Toy Fair will expose a great improvement in plastics toys for the infant market. If such an improvement does not appear, the whole plastics toy industry, selling at from 19¢ to $19 per unit, is going to suffer further losses this year and probably in later years.

Furthermore, mothers' opinions on plastics toys effect mothers' opinions on plastics in housewares, furnishings, and other things.

For the sake of the whole plastics industry, plastics toys, particularly for children under five, had better be better this year.

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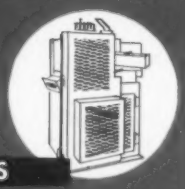

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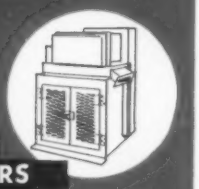

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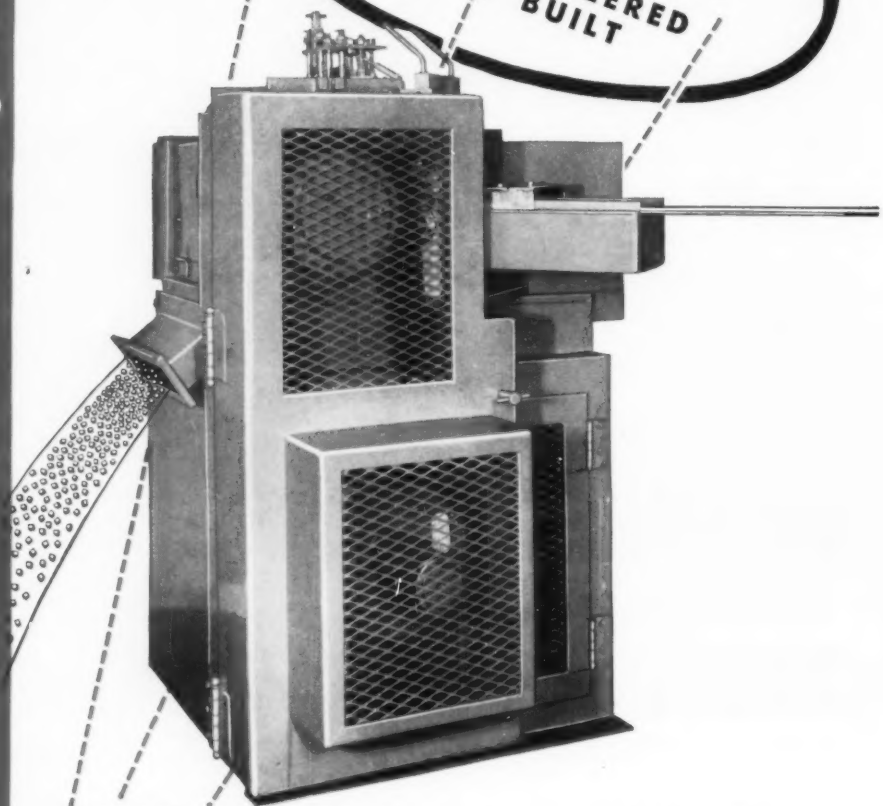

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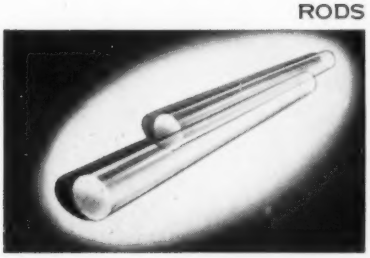

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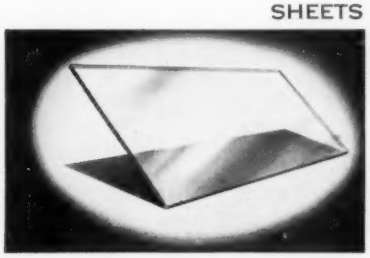

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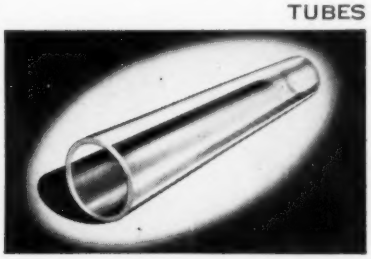

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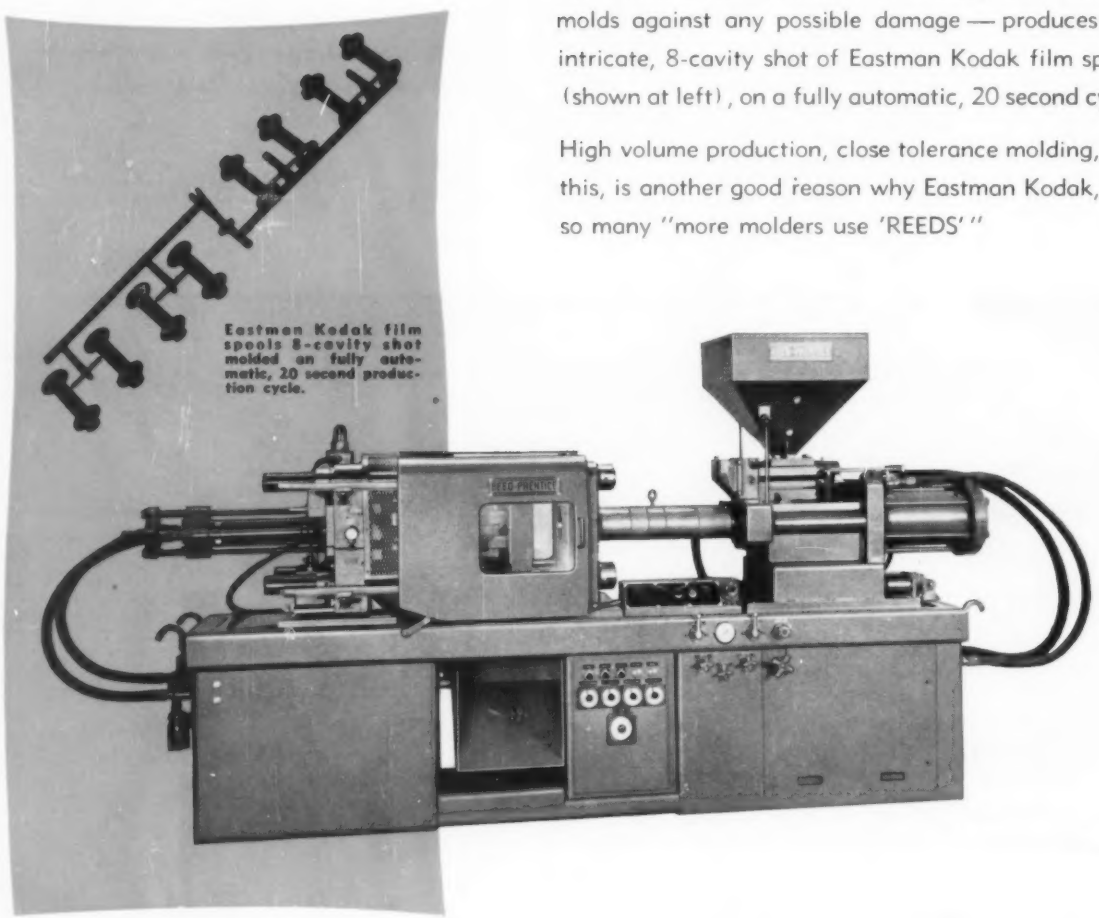

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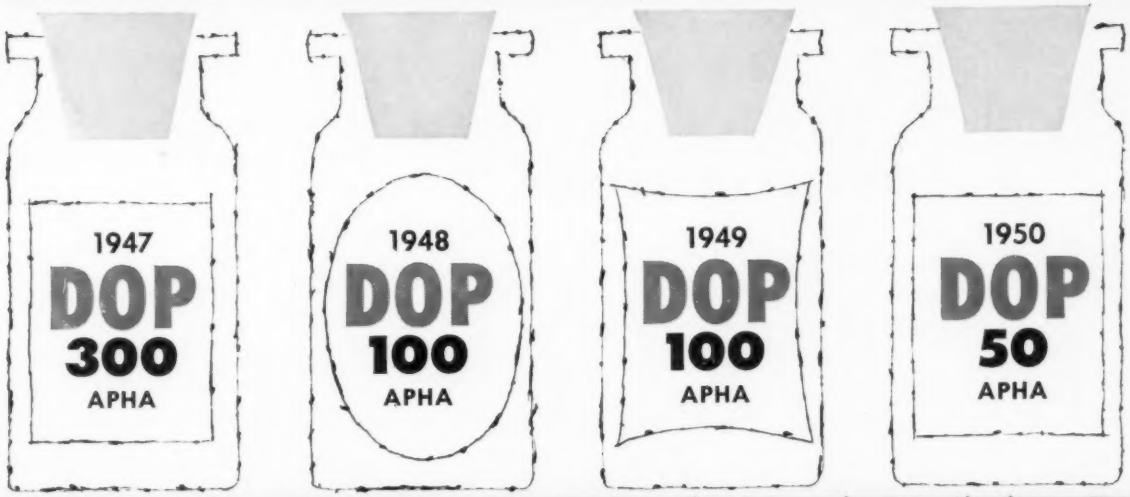

of the industry have been—and are—

those established by Eastman

Before Eastman began production of dioctyl phthalate the accepted industry color standard was 300 APHA.

The first Eastman specifications in 1948 called for production of a 100 APHA dioctyl phthalate. Then in 1950, this was lowered to 50 . . . and in 1954, to only 25.

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PRODUCT ENGINEERING NEWS

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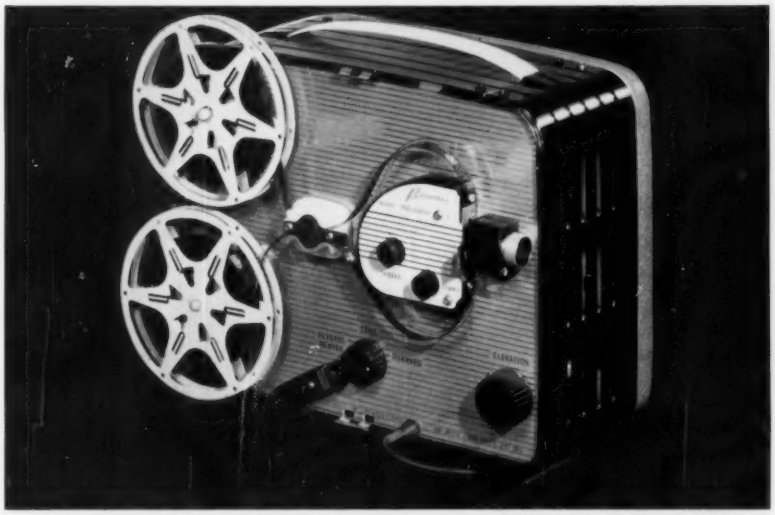
NO. 2 — 1955

10 Different Parts of "Zytel"* Nylon Resin Reduce Production Costs of Movie Projector



The design of this Brownie Movie Projector utilizes ten different parts of Du Pont "Zytel" nylon resin. "Zytel" has excellent wearing characteristics, provides quiet operation and production economies. (Projector produced in the Camera Works plant of the Eastman Kodak Company, Rochester, New York.)

Longer wear, quieter operation with gears and cams of "Zytel"

TEN different parts of Du Pont "Zytel" nylon resin are used in Eastman Kodak Company's 8mm Brownie Movie Projector. These parts were incorporated in the projector's original design to take advantage of the unique combination of properties which "Zytel" offers.

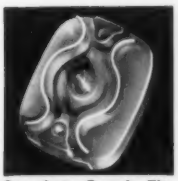
Production costs have been reduced by molding in "Zytel" a single part which replaces an assembly of machined metal parts. Generally speaking, parts of "Zytel" nylon are specified where metals had been used for equivalent parts in other projectors.

Less Wear, Less Noise

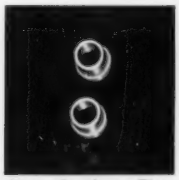
Gears and cams molded of "Zytel" improve the wearing characteristics of these parts. This engineering material is also resilient—damps noise so the projector operates more quietly. Certain moving parts of "Zytel", when oiled, retain this lubrication almost indefinitely. Total weight of the projector has been cut by using lightweight "Zytel" nylon resin.

Evaluate Du Pont "Zytel" nylon resin in terms of your own product-design problems. How can "Zytel" help you? By reducing wear of moving parts. By preventing a lubrication problem. "Zytel" will make your product lighter, quieter in operation, and more economical to produce.

We will be glad to send you information about "Zytel"—property data, applications, molding techniques. Simply fill out the coupon on the back of this page and mail it today.



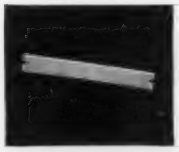
Sprocket Guard—Fits around the combination feed and take-up sprocket. Its function is to guide and hold the film on the sprocket.



Sleeve Bearings—These flanged sleeve bearings support the upper and lower reel spindles in the side frames, using five per projector.

Reel Spindles—These are stepped cylindrical parts molded to receive a spring-loaded ball detent. They hold the supply and take-up reels.

Pinion—A spur gear on the shutter shaft. The pinion meshes with large aluminum gear to transmit power to the sprocket shaft of the projector.

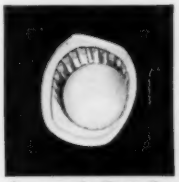


Liner (for Cam Follower Spring)—A piece of flat stock inserted between the cam and the follower spring. Keeps wear and noise at a minimum.

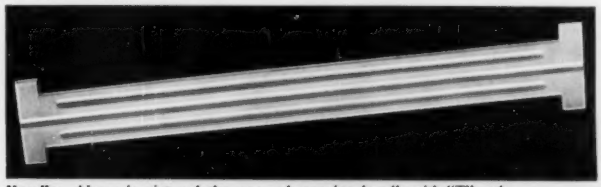
Framing Knob—This rapidly injection molded grooved knob with an eccentric hub is used to adjust the claw pivot to frame the picture.

Retainer (for ball bearings)—Annular piece with internal notches for spacing ball bearings on the cam hub.

Pulleys—Grooved pulleys for spring belts which drive take-up and rewind spindles. Two are used on each projector.



Cam and Threading Knob—Grooved knob of "Zytel" nylon resin with a cam that operates the pulldown claw.



Handle—Above is pictured the grooved carrying handle with "T" ends which anchor in slots in this movie projector. Du Pont "Zytel" nylon resin can be rapidly and economically fabricated into tough and long-lasting parts such as this handle. Projector manufactured by the Eastman Kodak Company of Rochester, New York.

*"Zytel" is the new trade-mark for Du Pont nylon resin.

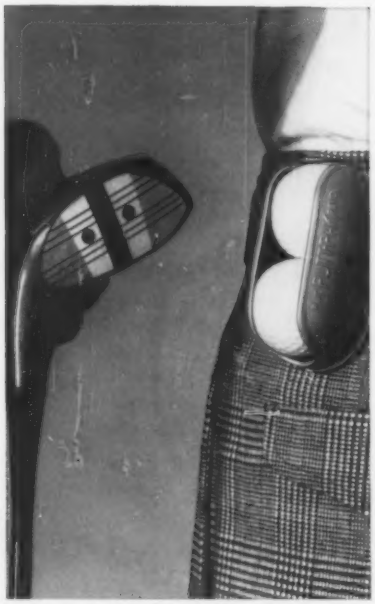
OVER

DU PONT

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 2 — 1955



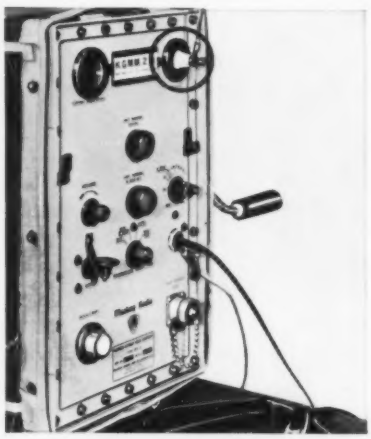
Clipped on the golfer's belt over his hip, this new "Putt-Pak" of Du Pont "Alathon" polyethylene resin makes a handy outside pocket for golf balls. Du Pont "Alathon" is used for this novelty item because it's flexible—yet retains enough stiffness to do the job and give long service. Another advantage: the rapid, economical fabricating techniques possible with "Alathon". (Manufactured by Plastic Enterprises Company, Cleveland, Ohio. Molder is R & K Tool and Die Company, Cleveland, Ohio.)

These closed-type vessels, used for heavy liquids and solids, are made of Du Pont "Alathon" polyethlyene resin. They are of rigid construction, have heavy wall section, are durable, and resist most common corrosives. The bottles and jars have a 1-quart, 2-quart, 1-gallon, 3½-gallon and 5-gallon capacity; the safety jugs hold 1½ and 3½ gallons and will support 20 and 50 pounds of contents, respectively. (Agilene bottles, jars, and safety jugs are manufactured by American Agile Corporation, Bedford, Ohio.)

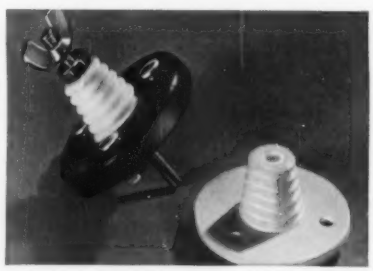
Lifeboat radio uses corrosion-resistant Du Pont TEFLON® for antenna post

Now "Teflon" finds a new use as the antenna post on a two-way portable lifeboat radio. This radio has a housing of anodized aluminum and is buoyed up by encased air when in water.

Conventional insulating materials tested for this antenna post failed for one reason or another. Some would chip and crack under the rough service this radio receives. Other materials deteriorated from salt spray. Only "Teflon" had the dielectric properties, strength, and corrosion-resistance to do the job.



This lifeboat radio uses an antenna post of Du Pont "Teflon" tetrafluoroethylene resin (circled) which resists salt-water corrosion and has strength enough to take rough handling without cracking.



Close-up of antenna post of "Teflon". Of all the insulating materials tested, only "Teflon" was satisfactory for this heavy-duty application. (Radio manufactured by Marine Division, Mackay Radio & Telegraph Company, New York City. Insulator of "Teflon" made by Tri-point Manufacturing & Developing Company, Brooklyn, New York.)

Investigate Du Pont engineering materials in your product development programs

ONE of the family of these versatile engineering materials is often a key factor in product improvement or new design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"† nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION? Clip the coupon for additional data on the properties and applications of these Du Pont engineering materials.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 303, Du Pont Building, Wilmington 98, Delaware.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for:*

NAME _____ POSITION _____

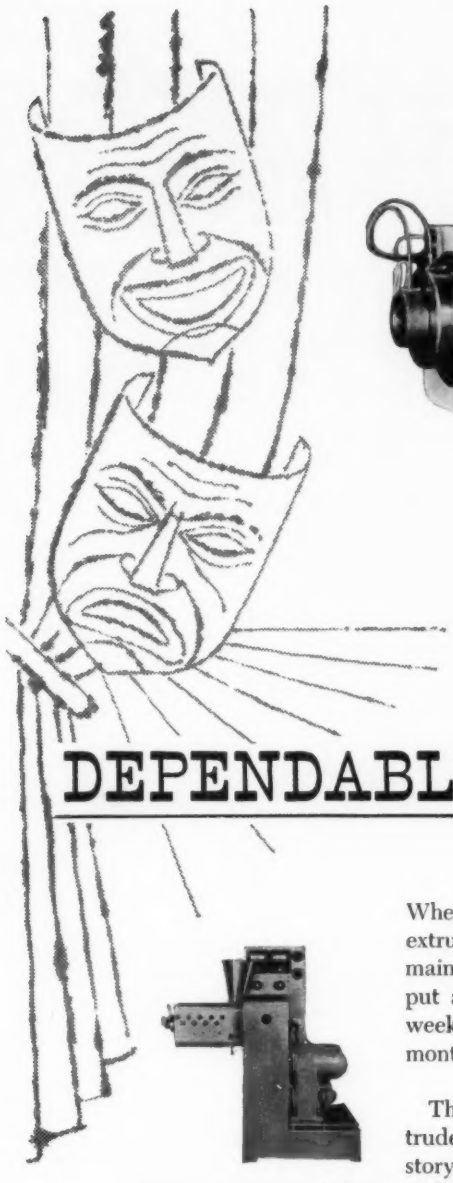
COMPANY _____

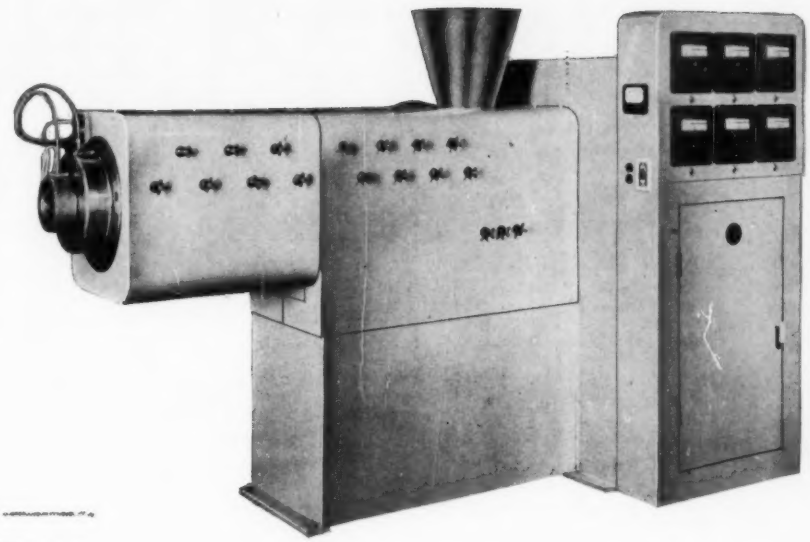
STREET _____

CITY _____ STATE _____

TYPE OF BUSINESS _____

*"Alathon", "Lucite", "Teflon" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)
†"Zytel" is the new trade-mark for Du Pont nylon resin.





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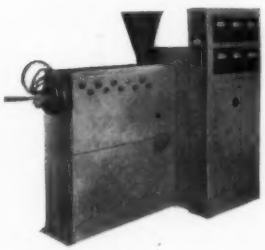

MPM extruders, in all sizes, are in daily use in more than eighteen countries, outside of the United States.

When the "show must go on" MPM extruders can be depended upon to maintain close tolerances, high output and uninterrupted production, week after week, month after month, year after year.

The experience of countless extruders all over the world tells the story: MPM extruders are known to have the built-in endurance that insures production that is both continuous and profitable.

MPM extruders, in all sizes, have screws, strainers, cylinders, die heads, hoppers, and other vital parts which are made of corrosion resistant materials through and through.

And MPM extruders won't be outdated by the introduction of new plastic materials. Some models have as many as fifteen cooling zones . . . all have internally heated or cooled screws. Proof of their versatility can be found in the fact that nearly all material manufacturers use MPM's for laboratory development work.

Indications are that the demand for extruded products will grow for many years to come. Owners of MPM extruders and auxiliary equipment will be in the best position to meet this demand. Ask today for full data about an MPM extruder that will be your most dependable performer.

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In dry blending, much depends on the resin used. To achieve all the advantages possible, the resin must have the proper balance of blending and processing characteristics, without sacrifice of physical properties. Some resins give very dry, free-flowing blends which do not extrude or mold well. Others process well, but display poor flow. PLIOVIC EDB90V, however, exhibits the optimum balance of essential properties.

PLIOVIC EDB90V is a straight polyvinyl chloride, specifically designed and made for dry blending. Its particle size, shape and distribution is carefully controlled to give free flowing blends of excellent processability. Its physical properties are excellent and its electrical properties are such that it has been approved by Underwriters' Laboratories as fully interchangeable with all other electrical grade, vinyl resins.

Find out for yourself how you can put in less time, money and effort yet take out more of a better product by dry blending with PLIOVIC EDB90V. Full details, technical help and samples are yours by writing to:

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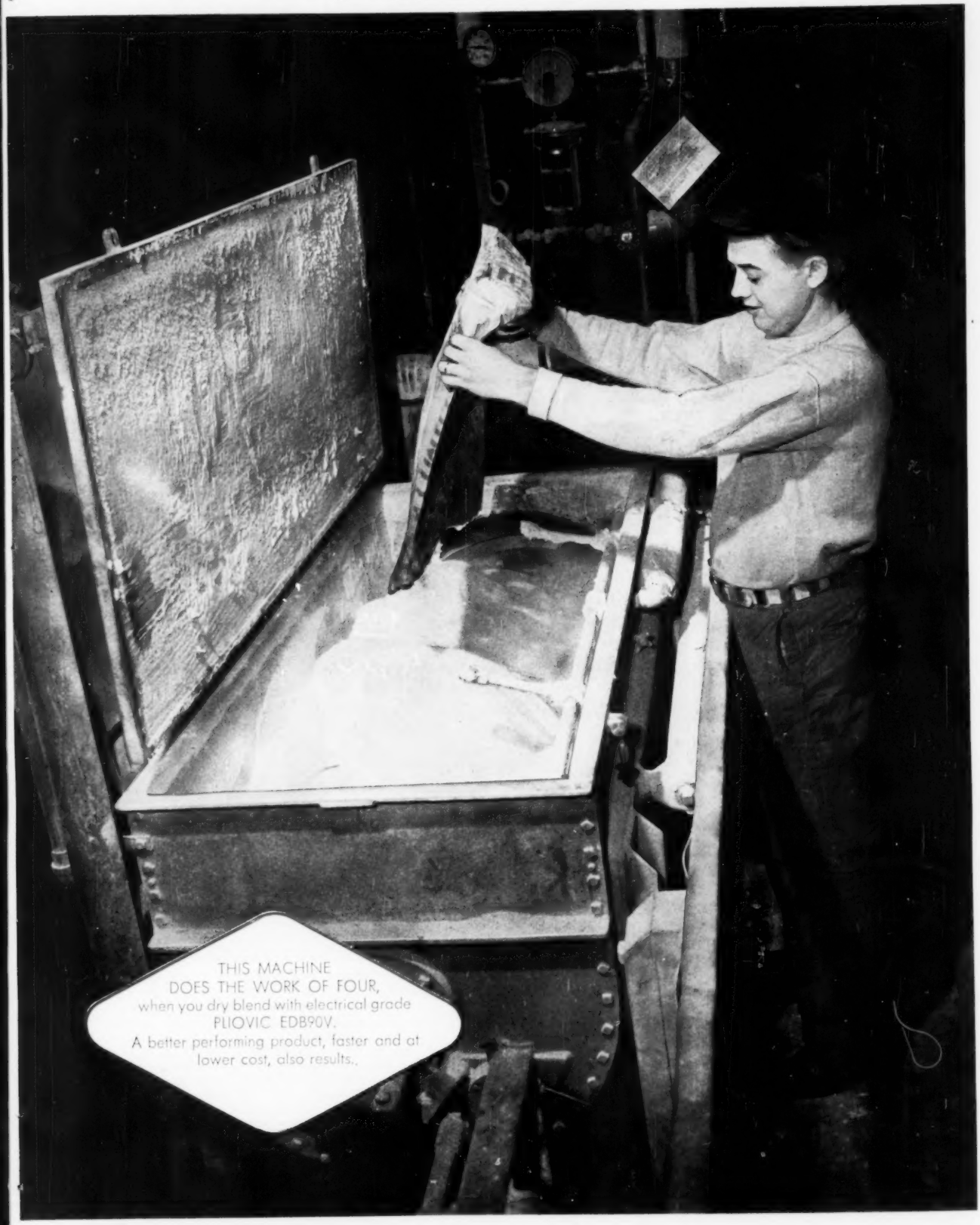
THIS MACHINE
DOES THE WORK OF FOUR,
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lower cost, also results.

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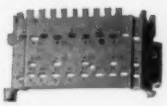
WRITE PLASTIC PRESS DIVISION
BAKER BROTHERS, INC., 1010 POST ST., TOLEDO 10, OHIO

Are you satisfied with your moulded plastic parts?

Does your part have to fly in the air?  and stand extreme temperature changes without cracking? Or is it buried in the ground--- subject to alkalies and impact? Does it have water on the inside and air on the outside? Contain steam? Or pass radar impulses? An electronic insulator? Pump sand or liquids? Or is it a bearing operating in acid? Or is it a "simple" knob that just isn't supposed to fall off?

If your problem isn't just price, but making your plastic parts perform a TROUBLE-FREE function in the field,--and in a way that does your brand-name proud--chances are we can be of some help to you. Others have found it so.Give us a try.

We specialize exclusively in plunger, transfer, and compression mouldings of all thermosettings plastics, glass reinforced moulding compounds and fluorocarbons. And we're ready for your job now!

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Above
PECO 2½" Universal Extrusion Machine

Left
PECO 30m Injection Moulding Machine

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Peco Injection Moulding Machinery is now well established throughout the world as equipment in which the best engineering skill and experience are combined with the latest developments in plastic technology.

A recent addition to the PECO range of machines for the plastics industry is the 2½" Universal Extrusion Machine which is illustrated above.

Illustrated literature is available on all PECO products and will be gladly sent on request.

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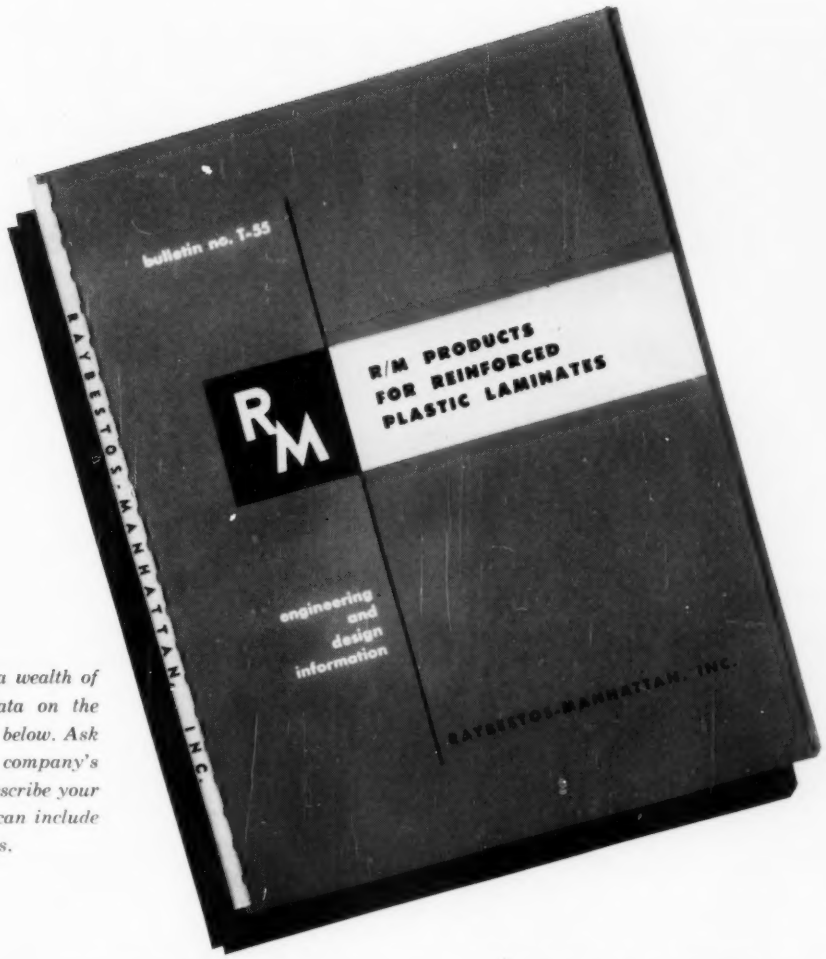

This brochure contains a wealth of technical and design data on the product groups described below. Ask for a free copy on your company's letterhead. If you will describe your reinforcement needs, we can include suitable recommendations.

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This entire building will be occupied by Atlas Electric Devices Co. for the manufacturing, testing, and research work of Fade-Ometers, Weather-Ometers, Launder-Ometers, Atlas Scorch Testers, and the Atlas Accelerator. After February 15, 1955, address all communications to the new address.

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and other principal cities throughout the world.

Only H-P-Ms Give Radio Makers What They Want!

Molding table model radio cabinets on one of two new H-P-M 20 oz. machines at General Industries, Marysville, Ohio.

Custom molders can't kid radio manufacturers when it comes to quality injection molding. These molding problems are in every cabinet job . . . off-center sprues, grills, inserts, intricate cores, heavy bosses, close tolerance holes for dials and clocks, perfect color match, high luster finish, strength and elimination of flow lines.

Yes, a radio cabinet is one of the injection molder's toughest jobs! That's why General Industries, Sylvania, Santay, General Electric and other leading cabinet makers use H-P-Ms. They have plenty of daylight and stroke for deep parts . . . extra plasticizing capacity . . . high speed injection . . . large platens to accommodate big molds.

Write for Bulletin 5406 describing the largest and most comprehensive group of injection machines ever offered to the plastics industry.

This new 20 oz. machine is the "hottest" production unit on the market. Completely new with plenty of daylight and stroke, large platens, large heating chamber, high speed injection. The 50 H.P. hydraulic unit, with sub-plate mounted valves, is extremely quiet. Weigh feeder is standard equipment. Write for complete details.

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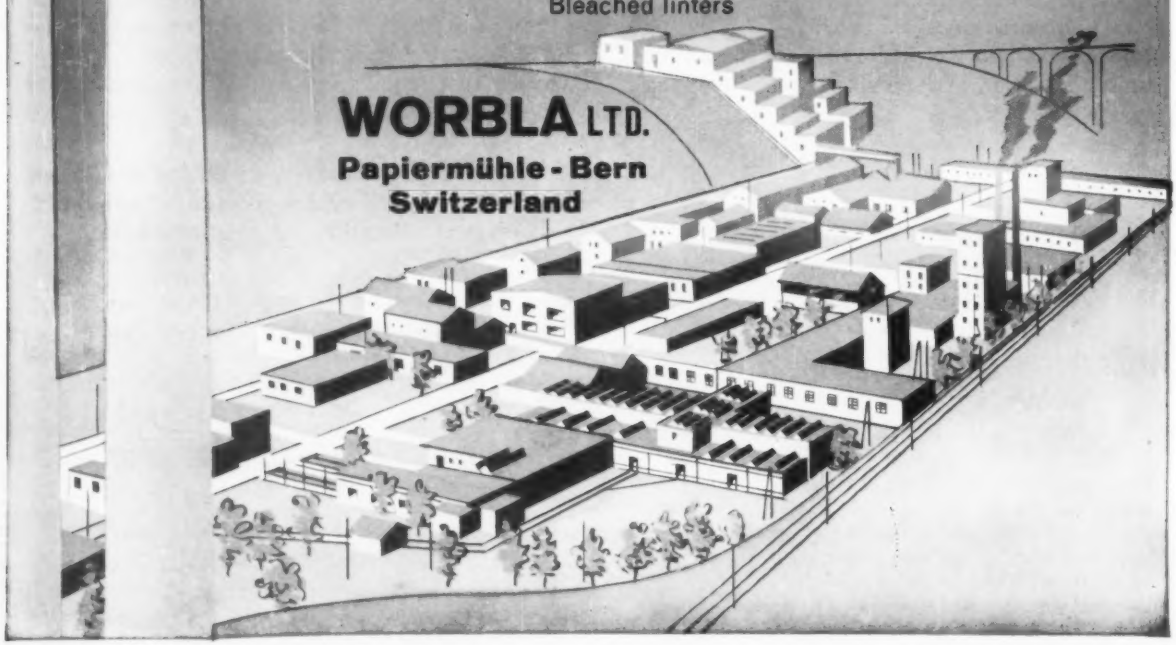

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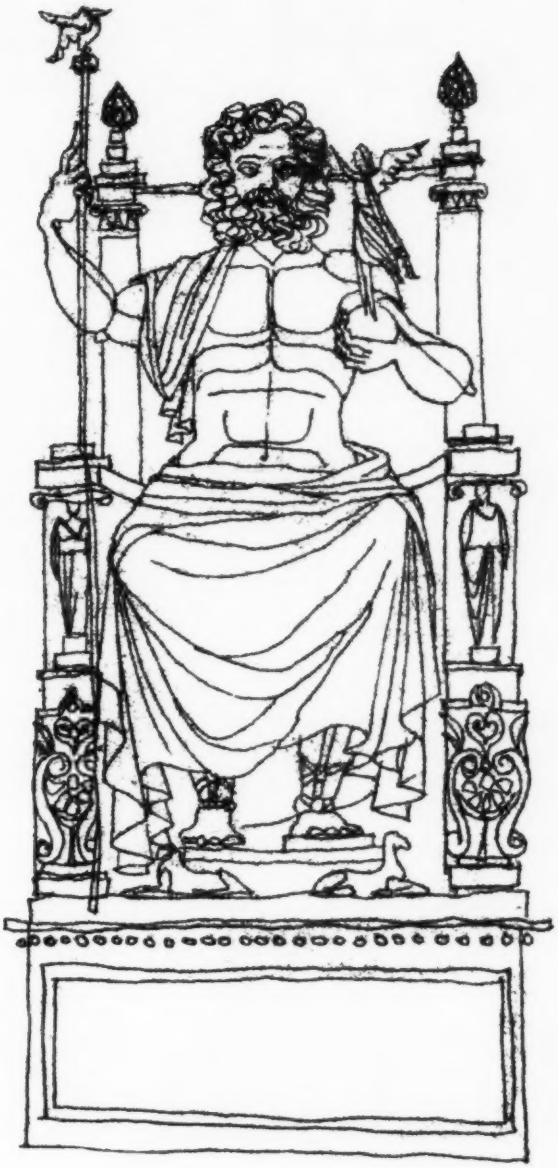

Truly one of the "Seven Wonders" of the world, the statue of Zeus, father of the Gods, was located at Olympia. This breath-taking icon made of gold and ivory was many times larger than life-size. Built about 450 B.C. by the Greek sculptor Pheidias it was a crowning triumph of artistic achievement.

Also quite an achievement, is Plenco's wide range of quality-controlled phenolics. We feel that through constant research and proven ability we can help you achieve a solution to any plastic problem you might have.

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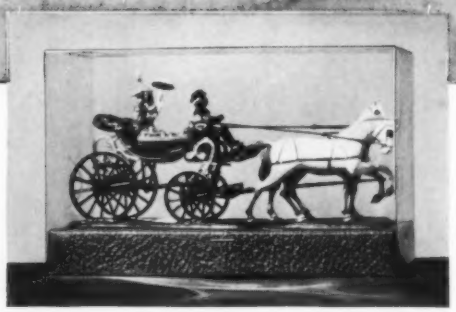
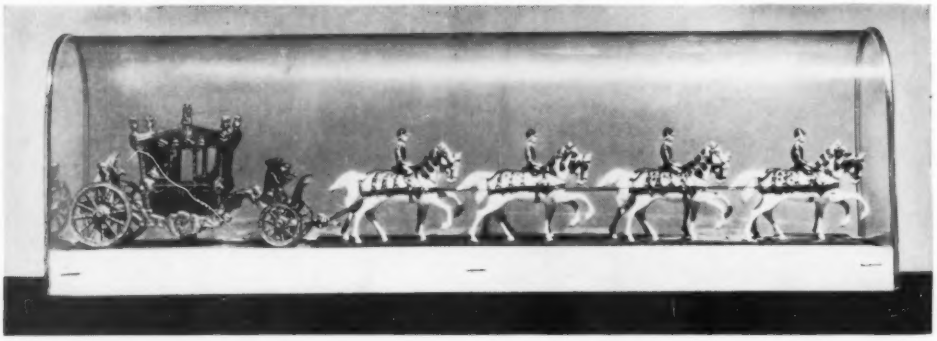
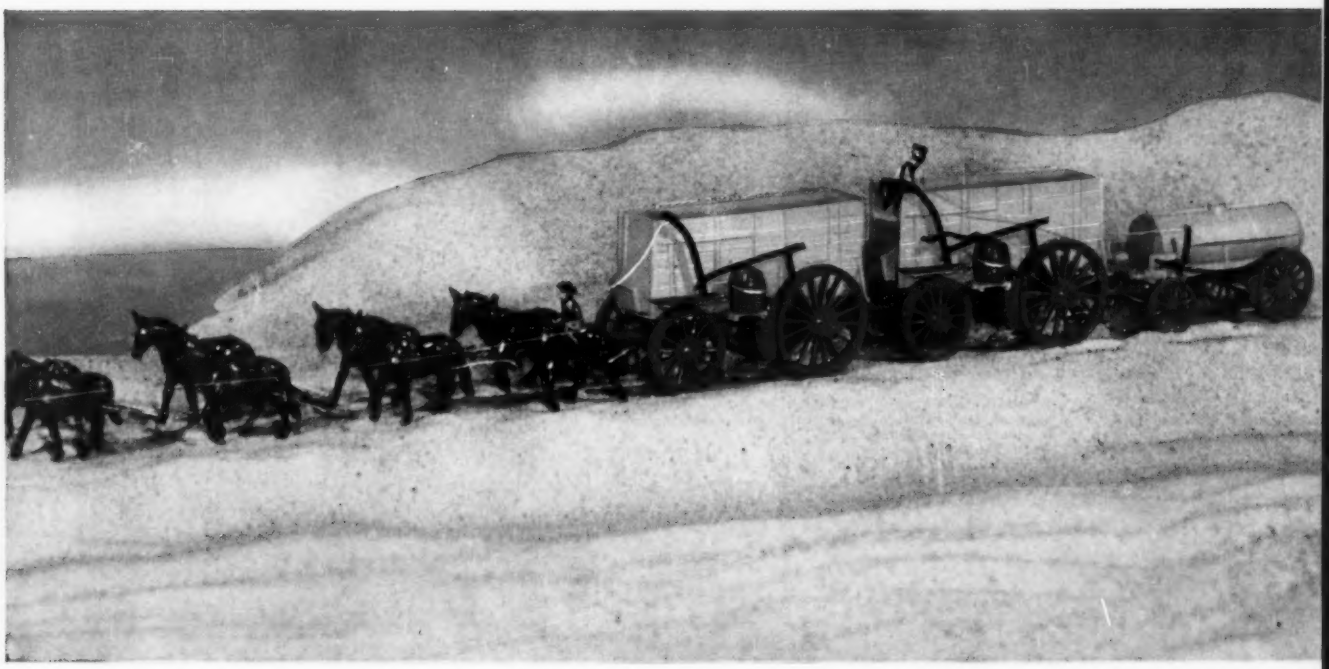




Wherever toys and hobbycraft are sold you will find displayed Revell's famous Miniature Masterpieces. Made of Celanese Acetate these scale replicas represent the finest in model design and construction. Mr. Henry Blankfort of Revell, Inc., Venice, California, has this to say about Acetate: "We use Celanese* Acetate because it permits the finest detail, so important in reproducing authentic model kits."

the plastic known to be tough enough for toys . . . models . . . premiums



Since the end of World War II, Acetate has been the acknowledged ***quality*** plastic for toys. Both the toy and plastics industry know Acetate as the ***original high impact plastic,*** and that nothing has happened in plastics research—or improvements made in other toy plastics — to unseat Acetate from its acknowledged leadership in combining these toy-quality essentials:

High impact strength
Great all around durability
Fine surface finish and permanence
Excellent machinability without stress failures
Good bond and cementability
Freedom from unpleasant odors

Mr. Toy Buyer write for your copy of this buying guide to quality toys. Just ask for the Celanese Acetate Toy Honor Roll.

To assist toy buyers and chain buying headquarters in obtaining durable, play-safe plastic toys that can be promoted with confidence, we have prepared an HONOR ROLL OF ACETATE TOYS. This brochure is profusely illustrated with the quality toys of America's leading toy manufacturers. It contains complete information about every toy: catalog number, size, retail price, etc., and can be used as a dependable buying guide by the retailer.

If you are manufacturing toys and are using Acetate plastic, you are invited to submit them for listing in this Honor Roll.

Celanese Corporation of America, Plastics Division, Dept. 101-C 290 Ferry Street, Newark 5, N. J. Canadian affiliate, Canadian Chemical Company, Ltd., Montreal and Toronto.

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*Reg. U. S. Pat. Off.

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. . . increases Sales Appeal and cuts Cost

Hobby horses to air conditioners, it pays to keep your product up to the minute in plastics. New materials, modern techniques bring product improvements that *increase sales appeal and cut costs.*

Give your product the benefit of Amos experience and ingenuity . . . with full facilities for engineering your product *correctly* and carrying it through *every step* of specialized production:

Product design . . . engineering . . . mold building . . . molding with 4 to 300-ounce machine capacity . . . conveyorized assembly and finishing . . . vacuum plating . . . silk screening . . . hot stamping . . . roller coating . . . printing . . . spray painting — all under one roof — no divided responsibility.

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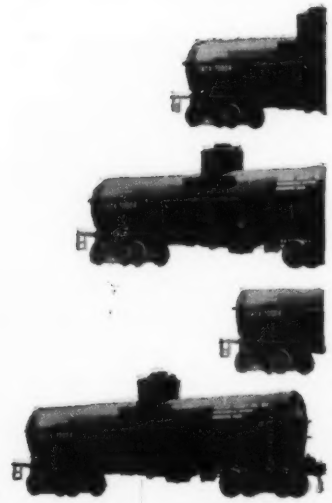
for Plastics applications . . . look first to Amos

A product of progress

THROUGH INTEGRATION

FOSTARENE®

A VIRGIN POLYSTYRENE



Fostarene is produced by an independent practical molder dedicated to present and future uses of polystyrene...backed by long, successful experience ...tested and proven in injection molding production.

FOSTARENE IS AVAILABLE IN PELLETS AND GRANULES.

EXCLUSIVELY REPRESENTED BY:

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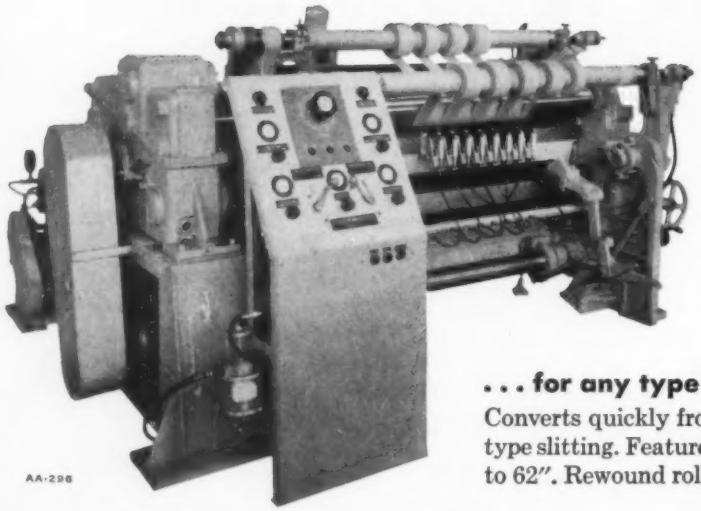
FOSTARENE® PETROCHEMICAL DIVISION **FOSTER GRANT CO., INC.** LEOMINSTER, MASS

A PIONEER IN PLASTICS FOR OVER THIRTY YEARS

Choose your biggest money-maker!



NEW CAMACHINE®

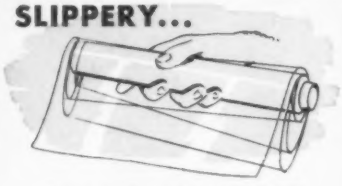
500

SLITTER-REWINDER

. . . for any type of film, foil, paper or fabric

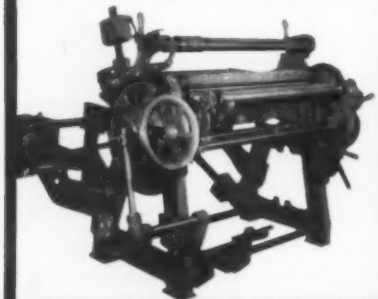
Converts quickly from score-cut to shear-cut or razor-type slitting. Features panel board control. Trim widths to 62″. Rewound rolls to 20″ dia. Speeds to 2000 fpm.*

SLIPPERY...

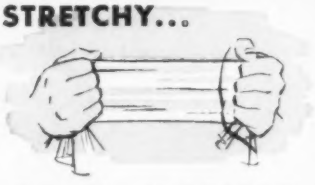


Camachine Model 26-7

Especially equipped for handling slippery materials such as cellophane. Three-point web control is provided through automatic constant tension unwind, driven feed rolls, and differential rewinding. Trim widths to 62″. Rewind rolls to 16″ dia. Speeds to 450 fpm.*

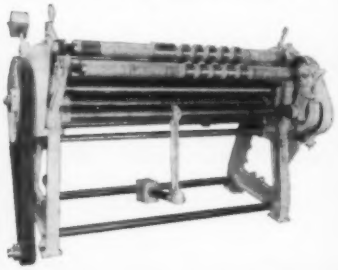


STRETCHY...



Camachine Model 26-R-7

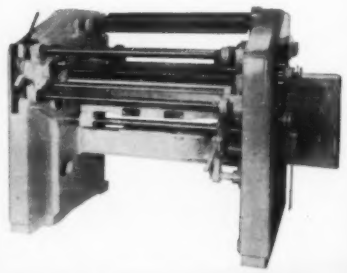
For stretchy materials such as polyethylene and other light gauge films. Razor-type slitting elements may be quickly replaced or respaced. Features an integral electrically braked mill roll shaft. Trim widths to 62″. Rewound rolls to 17¾″. Speeds to 700 fpm.*



TACKY...

Camachine Model 26-61PL

For lightly tensioned rolls of adhesive coated materials and other papers, plastics, or textiles which tend towards excessive adhesion of plies in the finished rolls, especially after long storage. Trim widths to 62″. Rewound rolls to 3″ dia. Speeds to 250 fpm.*



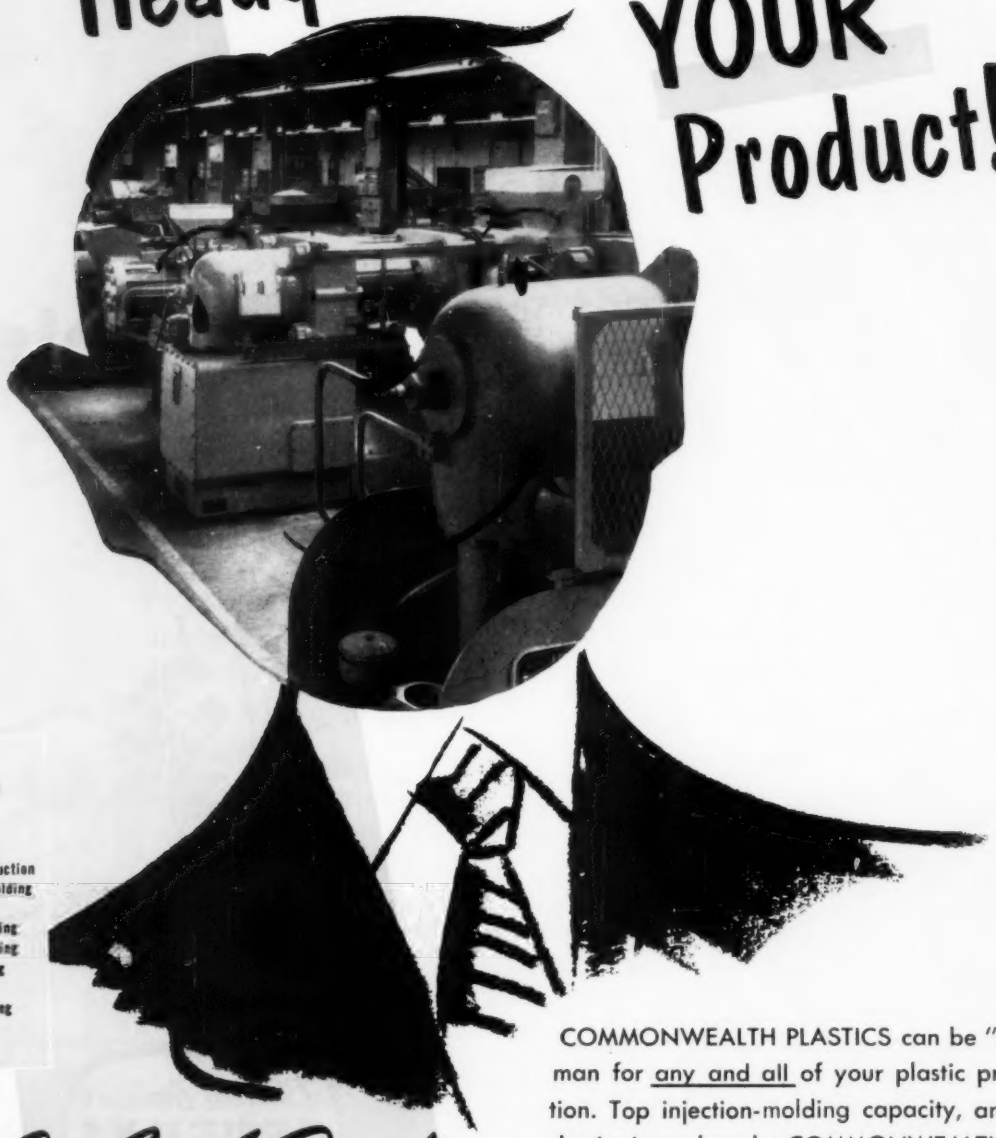
To help select the right Camachine for economical production in your plant let us make a test run on your material producing rolls to your specifications. See your Cameron representative or write today.

**Speeds depend on characteristics of material, machine width, number of cuts and web tension.*

Don't wind up with less than a Camachine®

Cameron Machine Company • 61 Poplar Street • Brooklyn 1, N. Y.

"Headquarters for YOUR Product!"



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COMMONWEALTH PLASTICS can be "head" man for any and all of your plastic production. Top injection-molding capacity, and top plastics know-how let COMMONWEALTH take the whole design and production load off your shoulders!

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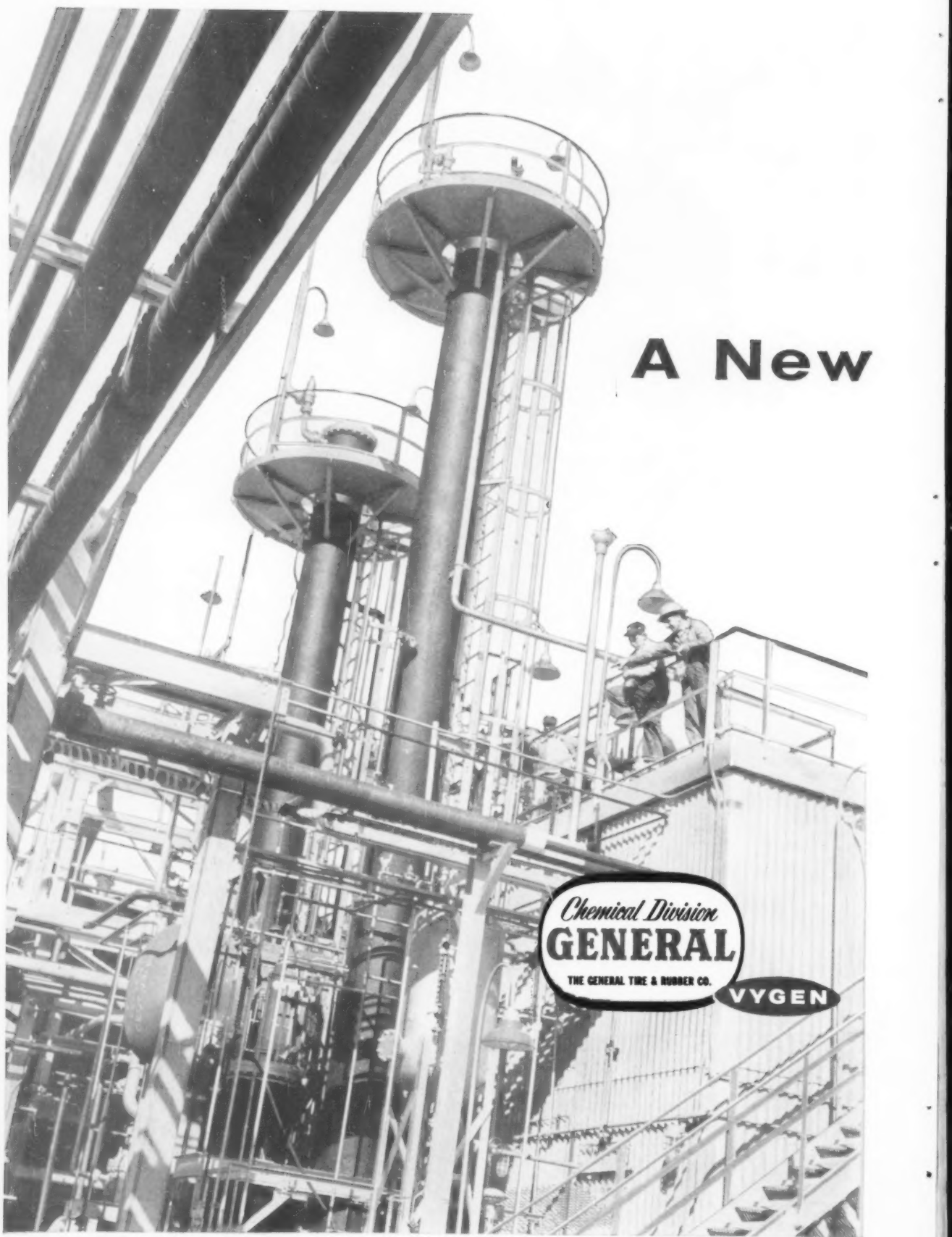
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Vinyl Resin Dedicated to Quality

Vygen* is more than just the name of another polyvinyl chloride resin. It is the reflection of the General Tire kind of quality . . . that which stems from the policy that no product is released to industry until it's "right" and ready.

Our ultra-modern new plant at Ashtabula will soon become a quantity source for Vygen. You'll be able to buy a Vinyl resin of consistent high quality backed by modern instrumentation, rigorous quality control, and production-testing in actual fabricating equipment.

Creating Progress Through Chemistry

General Tire also produces . . .
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Gen-Tac* (Vinyl Pyridine Latex) • Ko-Blend® (Insoluble Sulfur Masterbatch)
• Glykon* (Polyester Resin) • Polystop® (GRS Shortstop)

*T. M. G. T. & R. Co.

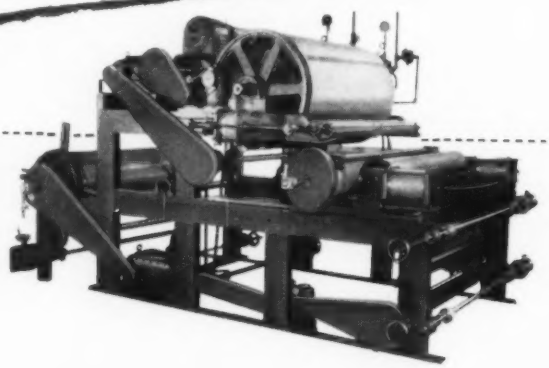
Off the Press!

LAMINATES, EMBOSSES, PRINTS in one operation!

The amazing new Laminator-Embosser that laminates **without adhesives** . . . embosses and prints in the same operation.

Completely flexible, the machine performs all three functions on all plastic films. It laminates stretch back or drills and valley prints to closest tolerances. Compact, costing a fraction of the price of mammoth equipment usually performing these jobs, it is especially practical on short runs.

If your operation can benefit by fast, flexible equipment at considerably lower outlay and upkeep, you're invited to see the new Lembo Laminator-Embosser in action. We will be happy to make experimental runs for you. Just write or 'phone LAmbert-5-5555.



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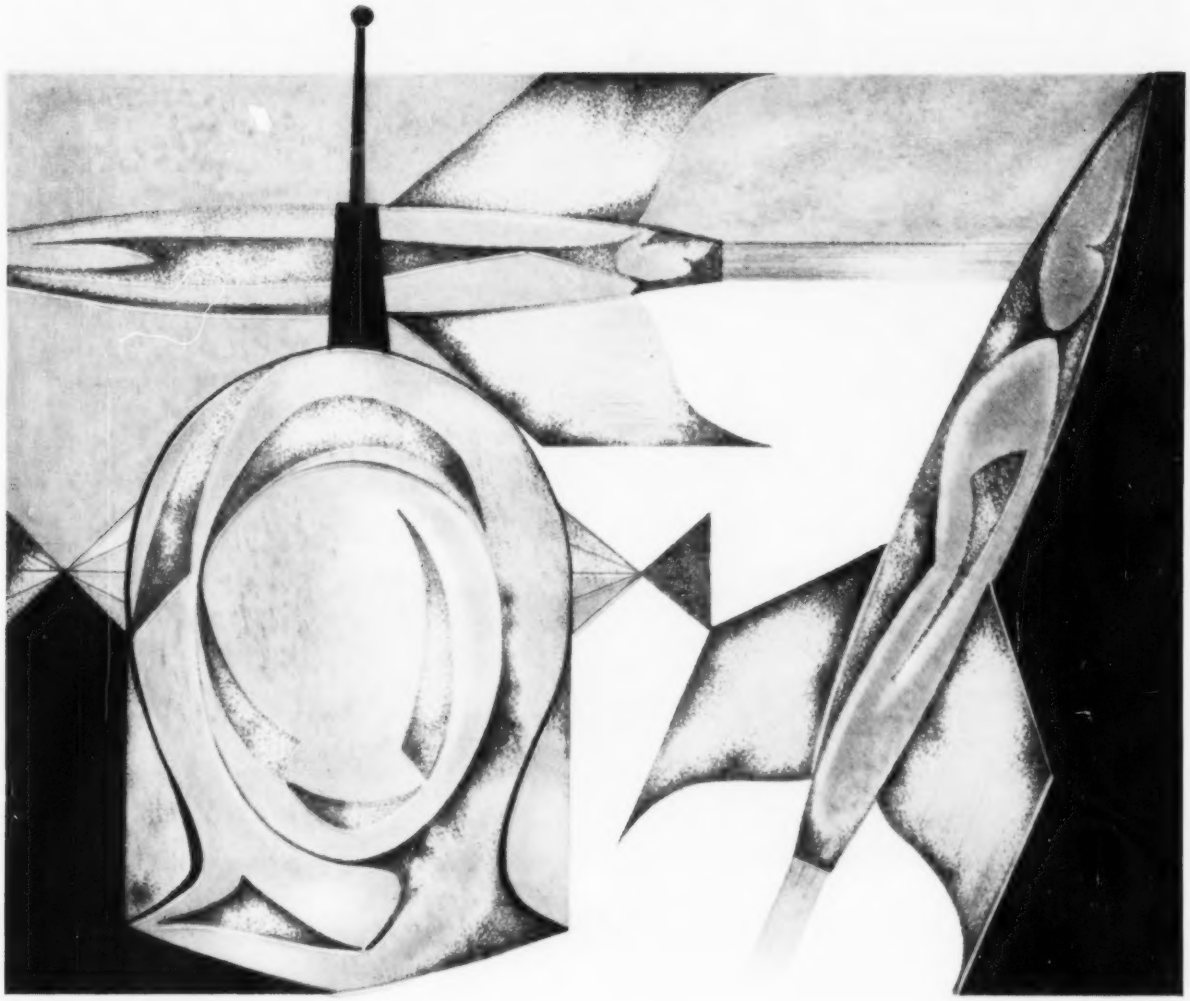
Why does man use color



DECORATION FOR PLASTIC TOYS

In performing their decorative function, colors — pigments — are attractive, set a mood. Plastic toy manufacturers delight children by incorporating pigments into the resins which they mold into exciting playthings.

Acheson supplies plastics fabricators with predispersed color for easy handling, greater tinting strength and streak elimination. There is an art to proper dispersion which Acheson has mastered in 50 years of operation. May we put this skill to work for you.

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ACHESON DISPERSED PIGMENTS CO.

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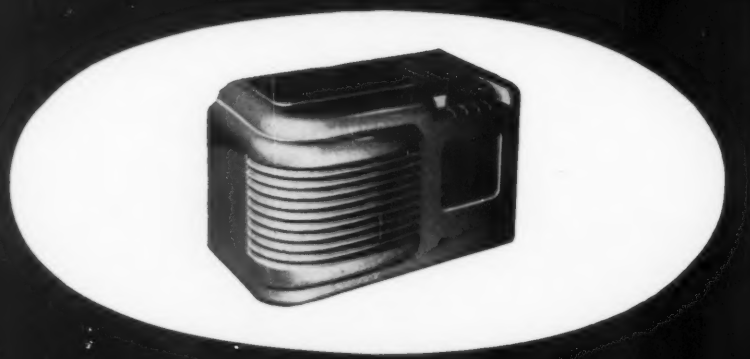
DISPERSIONS FOR THE PLASTICS AND PRINTING INK INDUSTRIES

for **TOUGH** molding jobs . . .



METASAP* STEARATES deliver easier mold release

When you have a tricky molding problem . . . when you're deep drawing or producing large pieces, Metasap Stearates in the molding compound provide outstanding lubrication for easy ejection from the mold.

Either incorporated into the molding compound or dusted onto mold surfaces Metasap Zinc or Calcium Stearates give outstanding lubrication so that lower ejection pressures are needed. Thus, you can expect increased output, fewer rejects, improved finished products and longer mold life.

So specify compounds containing Metasap Stearates or incorporate them directly into your own molding compound. Metasap Technical Service will help you with the proper material and mixing procedure for your needs.

. . . and to produce economical plastigels

As a thickening agent for plastisols, Metasap provides a complete line of quality Stearates. We'll be glad to make available to you free experimental samples of Magnesium, Barium, Calcium and Aluminum Stearates. They are ready for immediate shipment now.

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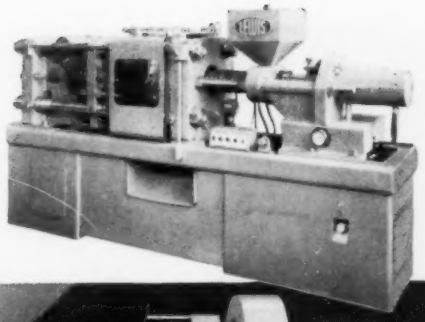
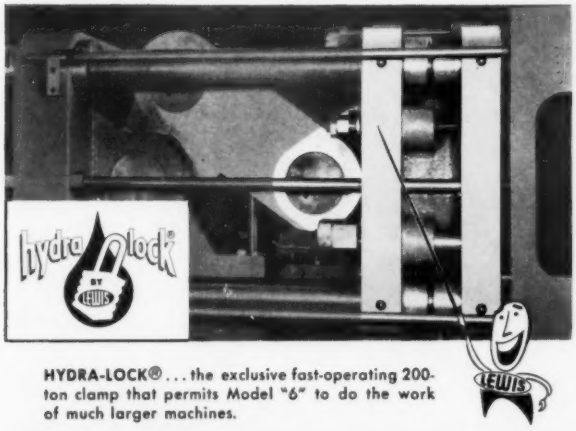
METASAP STEARATES

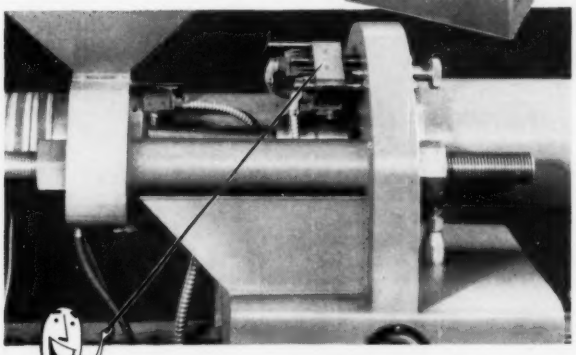
the cleanest stearates made

HERE'S WHY PRODUCTION MOLDERS SPECIFY THE LEWIS "6"

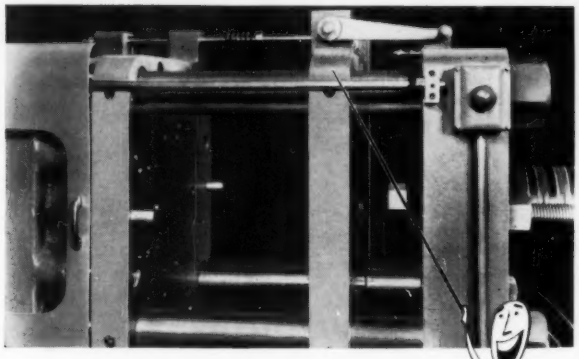




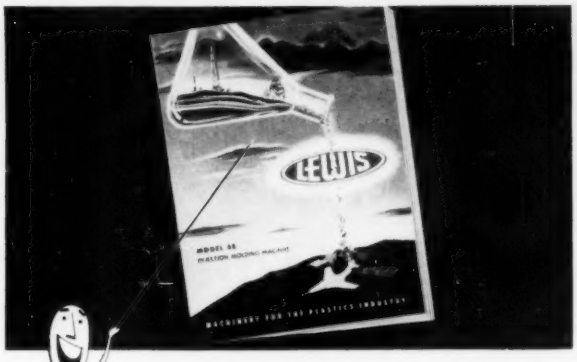
HYDRA-LOCK® . . . the exclusive fast-operating 200-ton clamp that permits Model "6" to do the work of much larger machines.



COMPENSATING FEED MECHANISM . . . that provides continuous compensation between feed and injection while machine is operating.



SPECIAL DIE-LOCK DEVICE . . . another LEWIS exclusive, permits release of dies and clearing of jammed nozzle in 20 seconds.



FOR THE COMPLETE STORY . . . including other outstanding LEWIS "6" features and specifications . . . write today for BULLETIN 102.

The LEWIS "6" injection molding machine is designed to mold large projected area parts formerly requiring larger, more expensive machines . . . to do the job faster, better and at lower cost. This versatile new machine is creating excellent case histories for volume production with minimum scrap. Intricate polystyrene parts weighing more than 7 ounces have been molded at rate of 2-1/2 shots per minute.

Continual improvement . . . based on precision, safety and cost-conscious engineering . . . has made Model "6" one of the safest, most efficient molding machines available today. Its automatic cycle, powerful new clamping mechanism, high injection pressures, low cost operation and foolproof safety features are proving that the LEWIS "6" is the new champion among top-quality molding machines.

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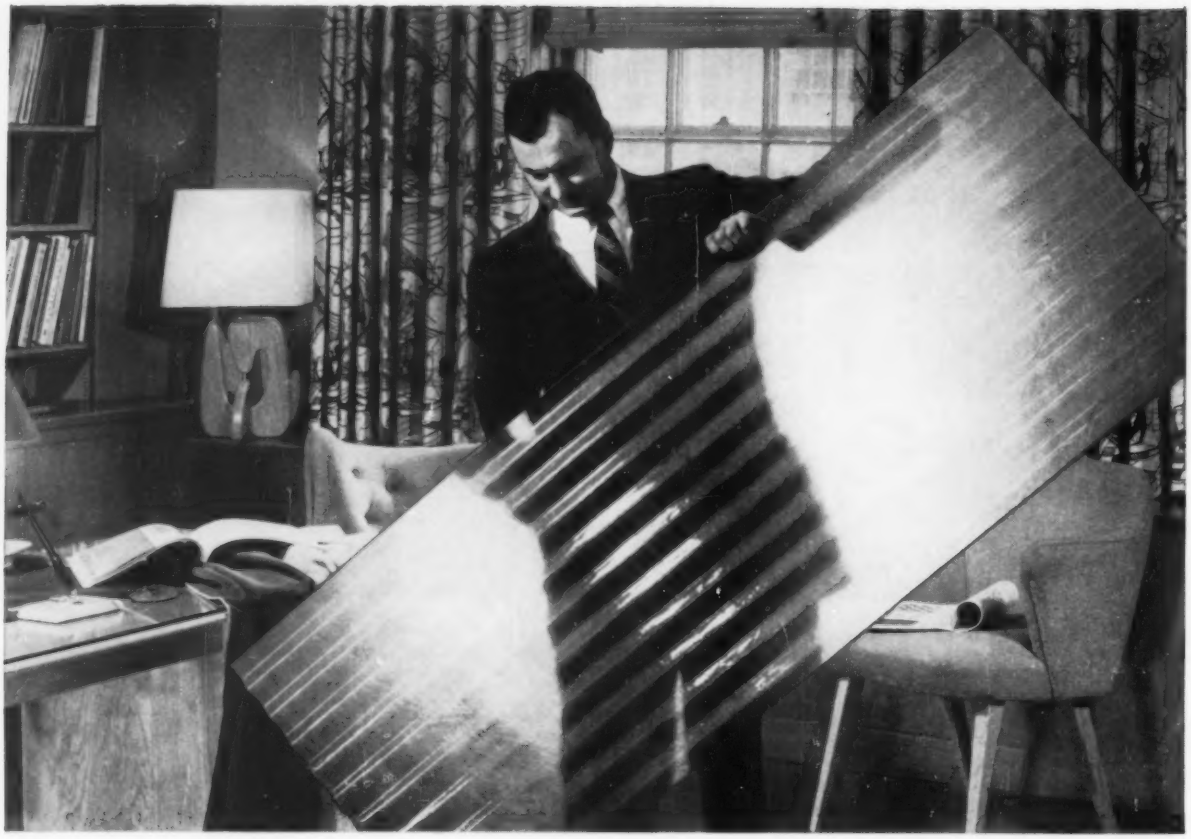

Now you can supply polyester-glass fiber panels with ***specific flame resistance***

More and more of your customers will be asking for polyester-glass fiber panels to meet building code requirements that call for a definite flame spread rating . . . panels and sheets you can make with HETRON* polyester.

"Locked-in" fire resistance

Structural panels, sheets, and other shapes made with HETRON are *permanently* self-extinguishing. Typical flame spread ratings of 75 or less (compared with 100 for red oak) by independent laboratory tests, place HETRON-based panels in a bracket equivalent to the Building Officials Conference of America classification of "slow-burning." Specific flame resistance is permanently, chemically locked in.

HETRON resins, in addition to their flame resistance, have high chemical resistance, low shrinkage on cure, excellent electrical properties, great resistance to heat degradation, and low permeability to air and water vapor.

They can be handled by standard techniques for curing, laminating, casting, and machining.

Write for complete technical data sheets listing properties of the liquid resins, cured unfilled resins, and glass cloth laminates. They include general handling and curing recommendations and other useful information.

*Trade Mark

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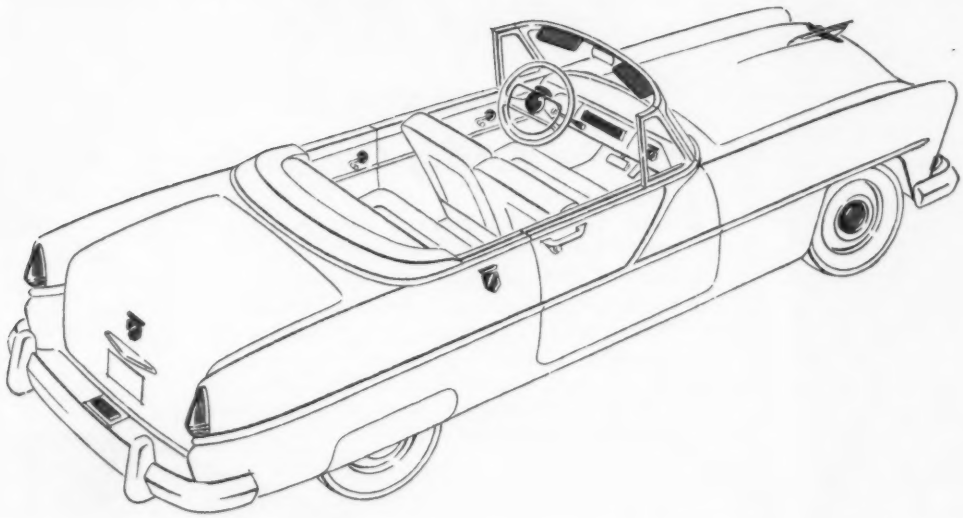

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Molded Parts

In more and more places on today's cars, you'll find PLEXIGLAS acrylic plastic molded parts. Tail light and back-up light lenses, front and rear medallions, instrument panels, parking light lenses, hood and steering wheel ornaments, hub cap inserts, sun visors, speedometer, radio, clock and gauge dials—all are being molded of PLEXIGLAS for the 1955 motor cars.

Parts molded of PLEXIGLAS have gem-like sparkle, rich color, resistance to breakage and heat, excellent dimensional stability and outstanding resistance to weather. We will be glad to send you a copy of our detailed brochure—"Molding Powder Product Design."

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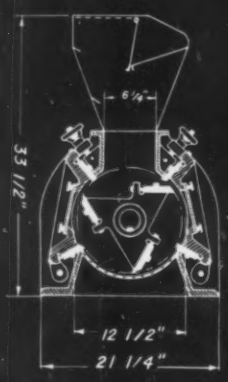
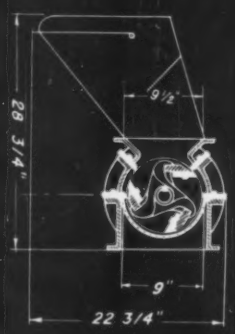
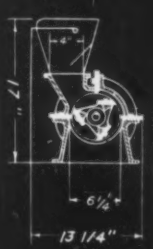
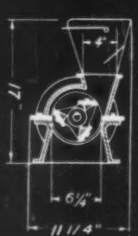
CONDUX

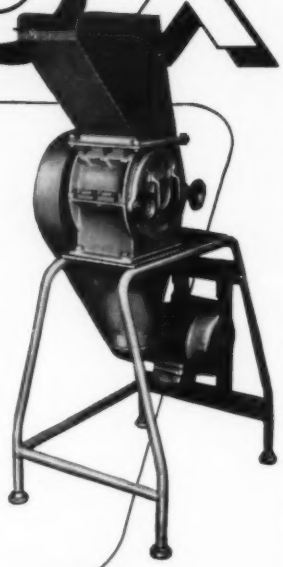








Cutting Mills
For Granulating All Injection Molding Compounds



- Quick disassembling and easy cleaning owing to perfect design and very simple construction.
- Uncomplicated exchange of screen plates.
- Cutting blades easily accessible for adjustment.
- Feeding of cords and skeins thru infinitely variable feed rolls.
- Cooling down or carrying away of hot granulated materials or substances sensitive to heat by means of built in pneumatic conveying.

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and

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***NOTE:** We offer top prices for distressed inventories of molded parts, purgings and all thermoplastic materials.*

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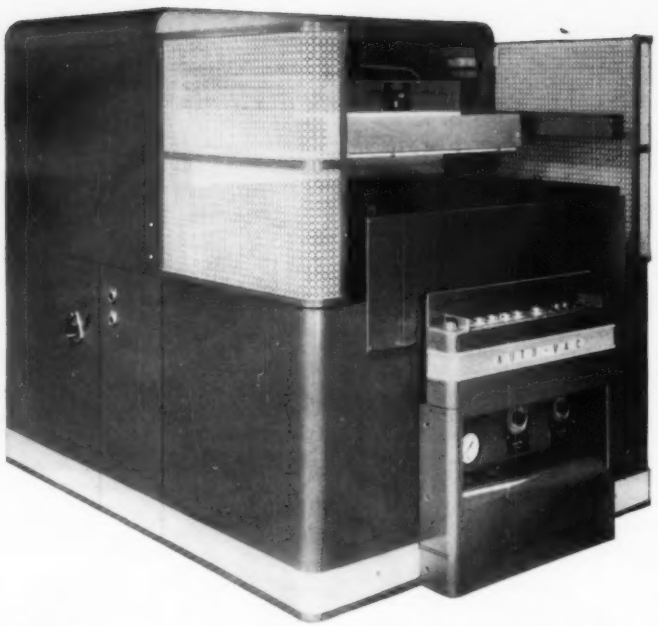
designed with experience gained from 250,000 production hours last year on Auto-Vac machines



the *New*

AUTO-VAC

- **New Completely Automatic Cycle — Operator simply loads plastic sheet and removes finished parts.**
- **New High Pressure Drape — Only Auto-Vac's patented Synchronized Toggle Drape means accurate and steady production.**
- **New Revolutionary Clamp Frame — Completely adjustable clamp frame can be changed for a new product in 4½ minutes — No parts to make.**
- **New Fast Heater — Auto-Vac's Super Uniform Heater gives faster overall cycles with low power consumption.**
- **New Ultra Safety Features — Completely guarded front and sides — Two handed starting buttons keeps operator's hands safe.**
- **New Micro Second Control — Fine accurate controls allow over 16 different plastics to be molded with simple adjustment.**

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Winning Combination

Good Machinery — Trained personnel and reliable guidance — Auto-Vac trains your personnel at its plant and helps you set up your projects — Auto-Vac research keeps you abreast of the latest advances in vacuum forming materials and techniques.

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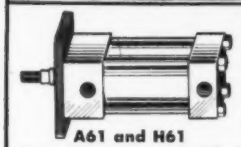
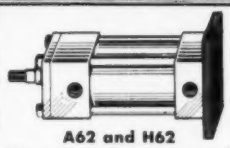
See Miller Bulletins A-105K (Air) and H-104K (Hydraulic) for Complete Dimensions and Engineering Data on these "in-stock" sizes and other Custom Miller Cylinders in bores up to 20" and strokes up to 22 feet.

"IN-STOCK" MODELS

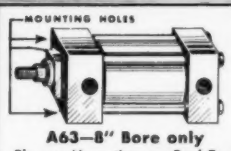
"A" Signifies Miller 200 psi Air Cylinders; "H", 2000 psi Hydraulic Cylinders. Interchangeable Mountings Are Shown In Rod On Drawings.



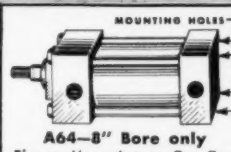
A61 and H61
Flange Mounting on Rod End



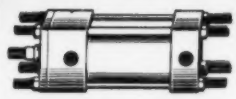
A62 and H62
Flange Mounting on Cap End



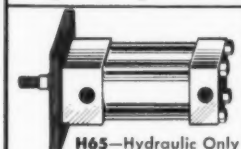
A63—8" Bore only
Flange Mounting on Rod End



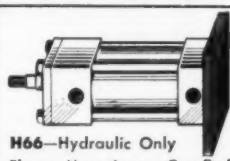
A64—8" Bore only
Flange Mounting on Cap End



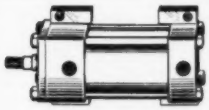
A50 & H50—Tie Rods not extended beyond nuts.
A51 & H51—Tie Rods extended both ends (shown).
A52 & H52—Tie Rods extended. Cap End only.
A53 & H53—Tie Rods Extended. Rod End only.
A54 & H54—Two Tie Rods extended at both ends.



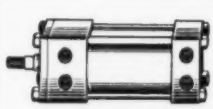
H65—Hydraulic Only
Flange Mounting on Rod End



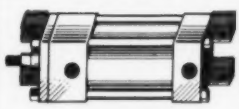
H66—Hydraulic Only
Flange Mounting on Cap End



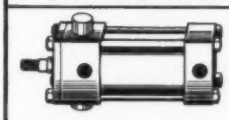
A72 and H72
Side Lug Mounting



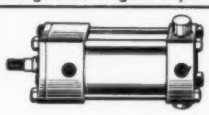
A74 and H74
Side Flush Mounting



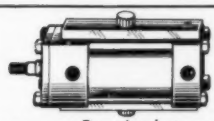
A77 and H77
Side or Foot Mounting



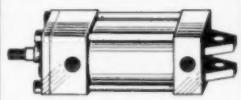
A81 and H81 Trunnion Mounting on Rod End



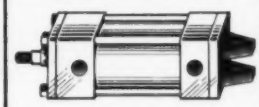
A82 and H82 Trunnion Mounting on Cap End



A83 and H83 Trunnion between Head and Cap (one week delivery)



A84 and H84
Pivot Mounting



A86 and H86
Pivot Mounting

IN STOCK BORES In Inches

"IN-STOCK" STROKES (in Inches)

	Bores	Rod Dia.	Rod Turn Down & Threads		1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
AIR	1½	⅝"	7/16-20	Cushioned																					
				Non-Cush.	1	2	3	4	5	6															
	2	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	6	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	8	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
HYDRAULIC	1½	⅝"	7/16-20	Cushioned																					
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1¾"	1¼-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	2"	1½-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36

① "A" and "H" Models 82, 84 and 86 with strokes over 18" require stop tubes.

Column strength requires larger diameter piston rods for the following:

Air Cylinder Models A82, 84, and 86 with strokes inside area (1), when operated at 100 psi and over;

All hydraulic models with strokes inside area (2) and Models H82, 84, and 86 with strokes in area (4), when operated at 2000 psi and over;

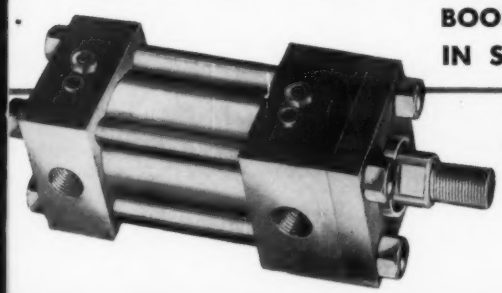
Models H82, 84 and 86 with strokes inside area (3), when operated at 1000 psi and over.

Depending upon Trunnion Pin location, "A" and "H" Models 83 with standard diameter piston rods can have longer strokes than Models 82, 84 and 86.

See Miller File #251 for oversize piston rod and stop tube requirements.

BOOSTERS IN STOCK

Immediate Delivery on the following Miller 25 to 1 Ratio Boosters (80 psi air input produces 2000 psi hydraulic oil output): Model 84, 5" bore, 1" dia. ram, 6" and 12" strokes; Reciprocating Booster Model DA77-RBA8, 5" bore, 1" dia. ram, 6" stroke. Also Booster Tanks, 5" dia., 6" and 10" heights.



Write For Catalog and Stock Price List

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will give a

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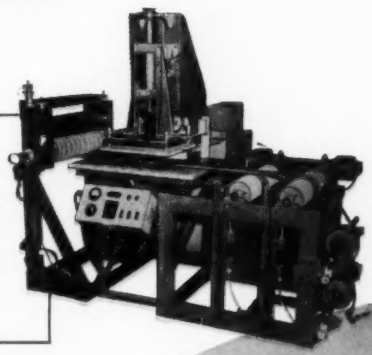
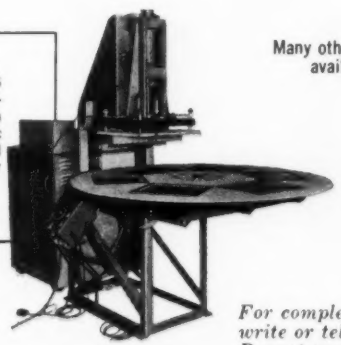
NOW, Thermatron offers a plan whereby you can turn in your present high frequency sealing and heating equipment for a liberal allowance toward newer, larger units that increase production and cut costs!



Thermatron Automatic Indexer used in conjunction with Thermatron electronic generator, feeds, indexes and rewinds complete rolls of vinyl in one automatic operation.



Large Thermatron P16 Press and automatic turntable used in conjunction with Thermatron electronic generator can be adjusted for up to 24 indexes per revolution.

Many other models available.

THERMATRON *for*

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- **Glue drying**
- **Reinforced fibre glass curing and asembly**
- **Plastisol curing**

...And many other applications

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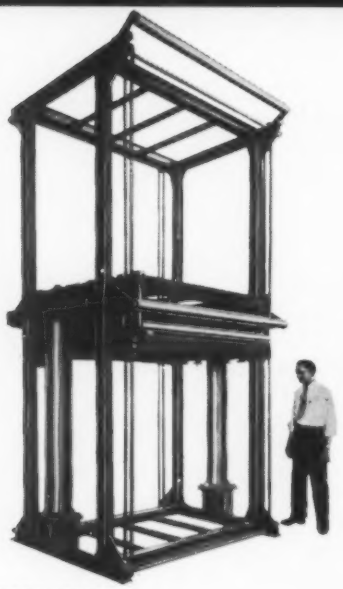
Rubber..... AND Plastics

CALENDER ACCESSORY EQUIPMENT



FESTOONER

A double-acting unit for handling various types of tire cord. It is used in conjunction with high-speed precision calendering equipment to store fabric while the let-offs or windups are stopped for roll changes.

Adamson not only engineers and builds a complete line of standard and special calenders, but in addition can supply all types of Calendering Accessory Equipment required for the continuous processing of rubber or plastics. Where special equipment is needed, our engineers are available to work with you in the development, design and construction of the right machinery or process to meet your requirement.

For over 60 years Adamson has pioneered in the advancement of rubber processing techniques, and today is a major supplier of equipment to manufacturers of rubber and plastics products the world over.

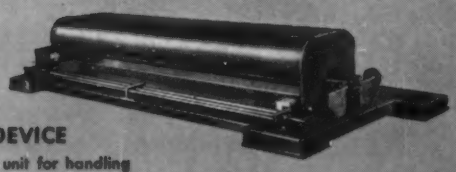
So keep in mind that whether it's Calenders, Calender Accessory Equipment, or any other type of rubber or plastics processing machinery, our experience, abilities and manufacturing facilities are at your service.

SINGLE ROLL COMPENSATOR STAND

For coordinating the speed of various elements in a calender train.

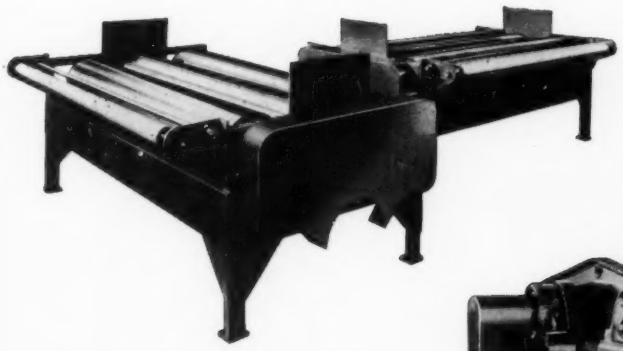
COMBINATION ACCESSORY TRAIN FOR PLASTICS CALENDER

Consists of Embossing Unit, Cooling Drum Stand, Compensator, and Two-Mandrel Automatic Turret Windup.



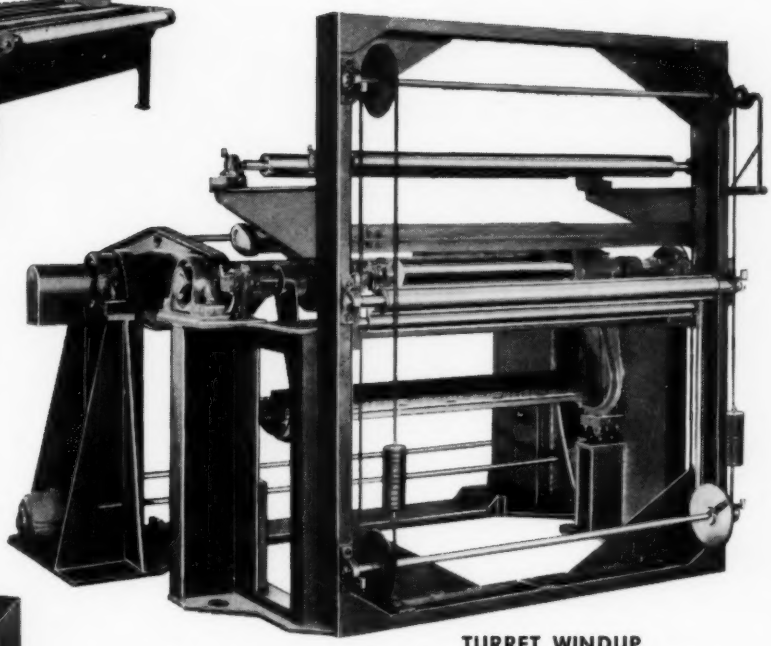
FABRIC CENTERING DEVICE

A rugged, 3-roll motor-driven unit for handling fire cord prior to its entry into the calender.



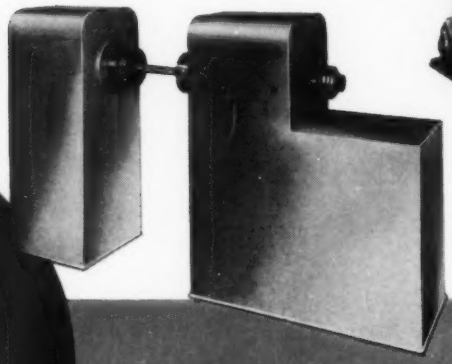
SURFACE WINDUP UNITS

Simple, conventional, drum-type windups for handling plastic film, plastic sheeting and coated fabrics.



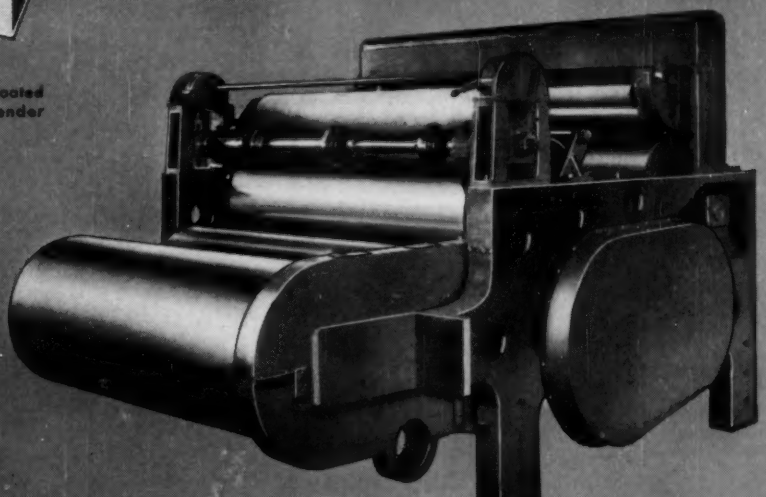
TURRET WINDUP

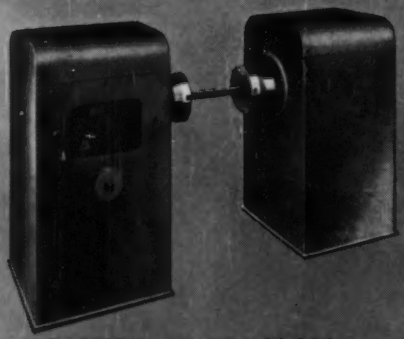
A special, center-drive windup designed specifically to wind very thin plastic film under accurately controlled, minimum tension. Equipment includes Two-Mandrel Turret, Automatic Counter and Cutting Device.



SIMPLE WINDUP STAND

Motor driven type for winding of coated fabric. Floor mounted type. Calender mounted units are also available.





FABRIC and LINER LET-OFF

Friction type, used in handling fabric for 3-roll universal calenders or for 4-roll double-coating calenders.

SPECIAL COMBINATION COOLING AND CUTTING DEVICE for RIGID PLASTIC SHEETING. Used with 4-roll calenders, with gear ratio changing equipment, to modify length of cut. Trim chopping device included.

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In Canada: Sylvania Electric (Canada) Ltd.,
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OR THIS?

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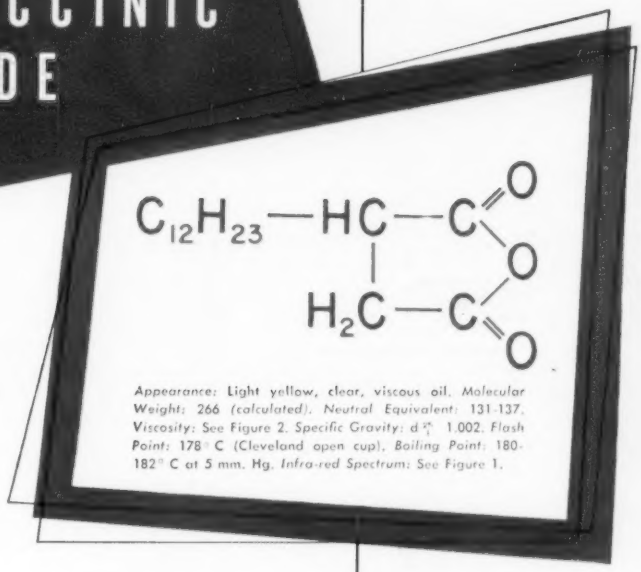
from the principal producer of Succinic Compounds

an interesting alkenylsuccinic anhydride

National DODECENYLSUCCINIC ANHYDRIDE



Appearance: Light yellow, clear, viscous oil. *Molecular Weight:* 266 *(calculated). Neutral Equivalent:* 131-137. *Viscosity:* See Figure 2. *Specific Gravity:* d_4^{25} 1.002. *Flash Point:* 178° C (Cleveland open cup). *Boiling Point:* 180-182° C at 5 mm. Hg. *Infra-red Spectrum:* See Figure 1.

The unusual molecular structure of this bifunctional alkenylsuccinic anhydride, reacting as an unsaturated compound and an acid anhydride, should interest all who work with

- ✓ Alkyd Resins
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- ✓ etc., etc., etc.

National Dodecenylsuccinic Anhydride is one more reactive chemical intermediate resulting from National Aniline Research on dicarboxylic anhydrides and related organics. National has ample basic production and many years experience in Succinic Compounds. We invite inquiries from those whose work may lead to substantial additional use.

WRITE FOR TECHNICAL BULLETIN I-B

This 6-page bulletin gives physical properties, chemical reactions, suggested uses and literature references.

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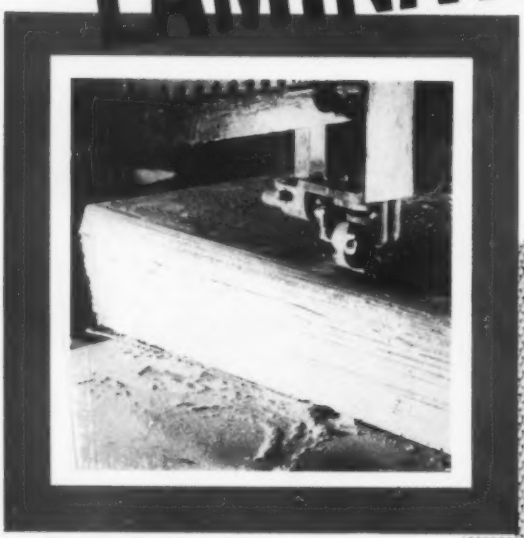

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Leading heat and light stabilizer for clear or opaque stock, an organic liquid complex containing no disadvantageous soapy component. Unequalled for stabilizing against effects of sunlight or outdoor aging.

BARIUM-CADMIUM 128-V-5

Leading combination of coprecipitated laurates for outstanding performance, where lubricating advantages are required. Generally 30% more effective than common barium-cadmium laurates.

Write for a Vinyl Stabilizer Check List that you may use to detail as much as possible your particular requirements.

A practical stabilizing system will be suggested promptly, based on our experience with the various Vinyl Polymers and Copolymers and with the different Plasticizers, for your processing and product end-use requirements.

THE HARSHAW CHEMICAL CO.
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Best effects are attained for particular requirements by combining 2-V-4 or 128-V-5 in a stabilizing system with one or more of the following three stabilizers.

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Compatible barium compound, minimum effect on viscosity. Permits processing at higher temperatures.

ORGANIC 8-V-1

Chelating agent, more than two times as effective as common organic phosphites. Inactivates harmful by-products to boost stability. Contributes to top clarity.

CADMIUM 22-V-1

For clear rigids or opaque. Stabilizes unplasticized resin efficiently and economically, with minimum effect on physical properties of product. Used with organic 7-V-4.

CADMIUM 28-V-2

For rigids, opaque to translucent. Stabilizes unplasticized resin efficiently and economically, with minimum effect on physical properties of product.

Stabilizing Systems developed for Harshaw Customers, for special processing and finished product properties, may contain one of the following fifteen stabilizers.

ZINC 9-V-1: Organic liquid complex containing no disadvantageous soapy component used in selected formulations.
CADMIUM 2-V-7: For modified solutions and organosols.
CADMIUM 228-V-1: For rigids, clear to translucent.
CADMIUM 24-V-1: Organic liquid complex for highest attainable clarity, used principally with dispersion resins.
CADMIUM 2-V-8: Selected laurate, used principally with low fusing resins.
BA-CD 12-V-5: Coprecipitated laurate.
ORGANIC 7-V-1: Epoxy assistant.
ORGANIC 7-V-2: Epoxy assistant.
ORGANIC 7-V-4: Epoxy assistant, for rigids.
BARIUM 1-V-3: Dispersible stearate, to contribute lubricity with barium effects.
BARIUM 1-V-6: For asbestos filled tile.
BARIUM 1-V-7: Liquid, for modified plastisols and organosols.
CALCIUM 5-V-1: Dispersible stearate, to contribute with calcium effects.
CALCIUM 5-V-2: Low melting stearate, to reduce internal friction effects.
CA-ZN 59-V-4: Non toxic metal content.

"PETROTHENE" * — polyethylene resins will be available in April from the new unit now being constructed by National Petro-Chemicals Corporation at Tuscola, Illinois. This completely integrated operation starts with natural gas as the source of ethane which is converted into ethylene in the world's largest petrochemical plant.

USI TO MARKET

polyethylene

FROM PETRO

"PETROTHENE" will be available in all quantities from fifty pound bag to carload through the nation-wide sales facilities of U. S. Industrial Chemicals Co. and will be warehoused at strategic locations for prompt delivery to processors. "PETROTHENE" will be available in grades specifically designed for use in film, bottles, pipe and injection molding. A new booklet on "PETROTHENE" will be available shortly.

*Application has been filed in the U. S. Patent Office for registration of "PETROTHENE" as the Trade Mark for polyethylene resins produced by National Petro-Chemicals Corporation, a joint enterprise of National Distillers Products Corporation and the Panhandle Eastern Pipeline Company.

U.S.I. INDUSTRIAL CHEMICALS CO.
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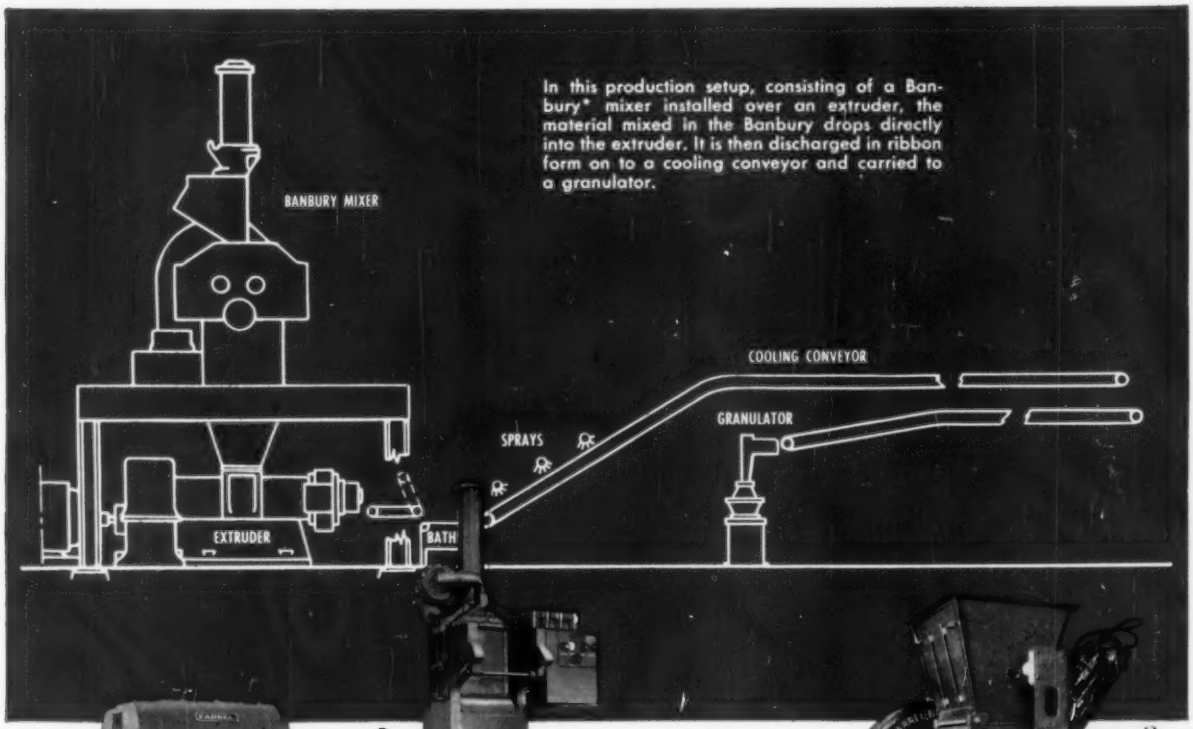
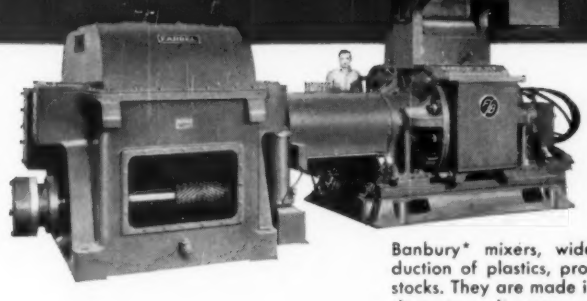
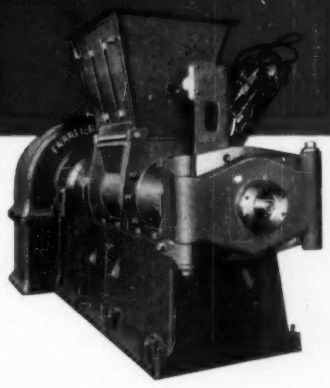
SIMPLIFIED, IMPROVED method of producing plastic materials in granular form



In this production setup, consisting of a Banbury* mixer installed over an extruder, the material mixed in the Banbury drops directly into the extruder. It is then discharged in ribbon form on to a cooling conveyor and carried to a granulator.



Banbury* mixers, widely used in the production of plastics, produce uniformly mixed stocks. They are made in a range of standard sizes to suit any capacity requirements.



Farrel - Birmingham extruders can be built for any capacity and provide the ideal answer to full utilization of maximum Banbury output.

The highly efficient processing system blueprinted here, has been installed by a number of large chemical companies to process plastics in preparation for granulation.

Operation is from a central control panel, and a continuous, even flow of production is maintained at all times by automatic cycle control of the Banbury* mixer, with extruder feed regulated to suit the cycle. The material is mixed and blended in the Banbury, and then delivered in chunk form to the extruder, where the stock is further worked by screw action under close temperature control. An air-operated ram in the hopper automatically provides constant feed to the screw. A continuous strip is extruded from the die head through a water bath to a conveyor, where the material is further cooled on its way to the granulator.

Another application for this production setup is for the reclaiming of vinyl scrap. The scrap is mixed and blended in the Banbury, then discharged into the extruder, where it is strained and extruded in strip form for subsequent cooling and granulation.

Send for further information.

FARREL-BIRMINGHAM COMPANY, INC.
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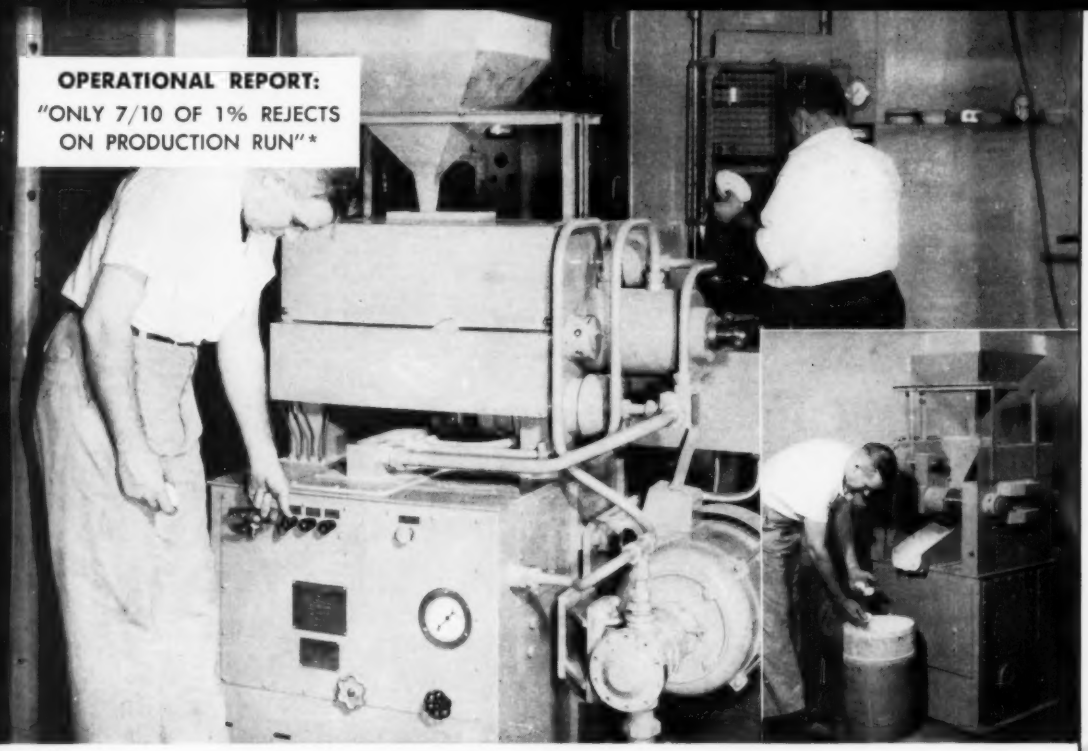
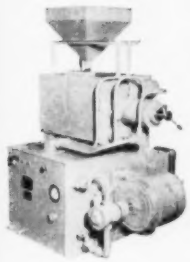
Other applications (please list) _____





Remarkable uniformity of preform density, weight and pre-heating with

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* Unsolicited reports like this . . . coming from field installations of internationally-famous BIPEL Horizontal Hydraulic Pelleters prove that these precision-built units are *unmatched in performance and economy* . . . anywhere! Just since their first public showing last June, installations are producing in key areas in 10 states! If you're investing in preformers, don't overlook the built-in features of the BIPEL, the service behind it, and the experience and integrity of the manufacturer. *Write for illustrated booklet and prices.*

Features: **Uniform Density** . . . die rides free during compression, allowing equivalent pressure on *both* punches. This, plus accurate hydraulic loading, insures constant uniform density. **Preforms Most Powders** . . main ram compresses powder only, with *steady squeeze*, not mechanical blow. Complete control for amount of "dwell" or pressure desired. Double pressing arrangement available to allow for escape of air in preforming difficult powders. **Damage-proof Operation** . . . no moving parts come between punches. **Clean, Quiet** . . . fills from *within* hopper for dust-free, quiet operation; can be cleaned in minutes between runs. **Labor Saving** . . . finished preforms are so strongly made that they may be discharged into tote boxes or drums unattended. One operator can easily supervise several units. **No Powder Loss** . . . all powder is pelleted; no spillage. **Higher Production Rate** . . . from multiple punch sets; punches for special shapes available. **Controls** of all operating variables located conveniently for instant settings. **Service** . . . all normal replacement parts in stock in U.S.A. for immediate shipment if needed. Electricals to suit.

maximum pressure	12 tons	35 tons	70 tons
maximum strokes per hour	2600	1500	850
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*based on average powder density of .35 ozs. per cubic inch

"BIPEL" is a Registered Trade Mark

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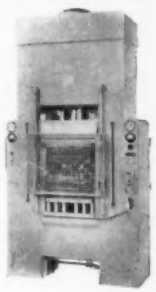

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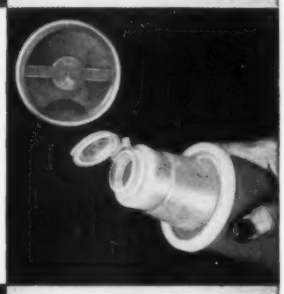

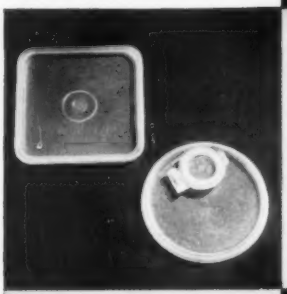

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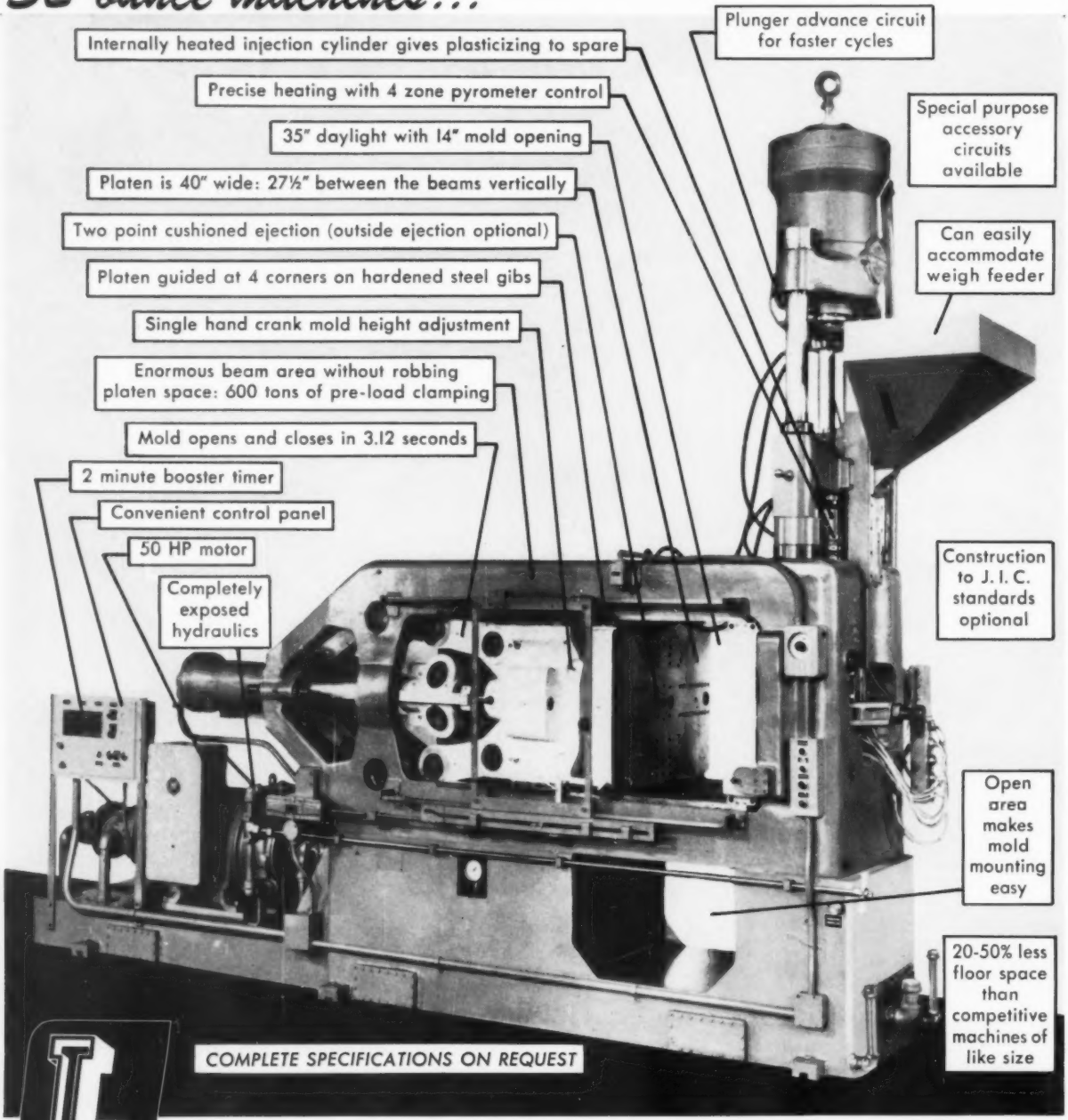
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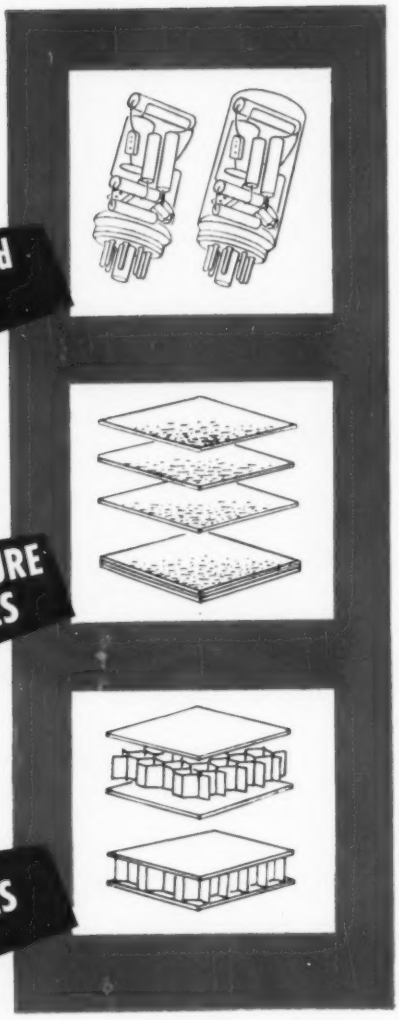

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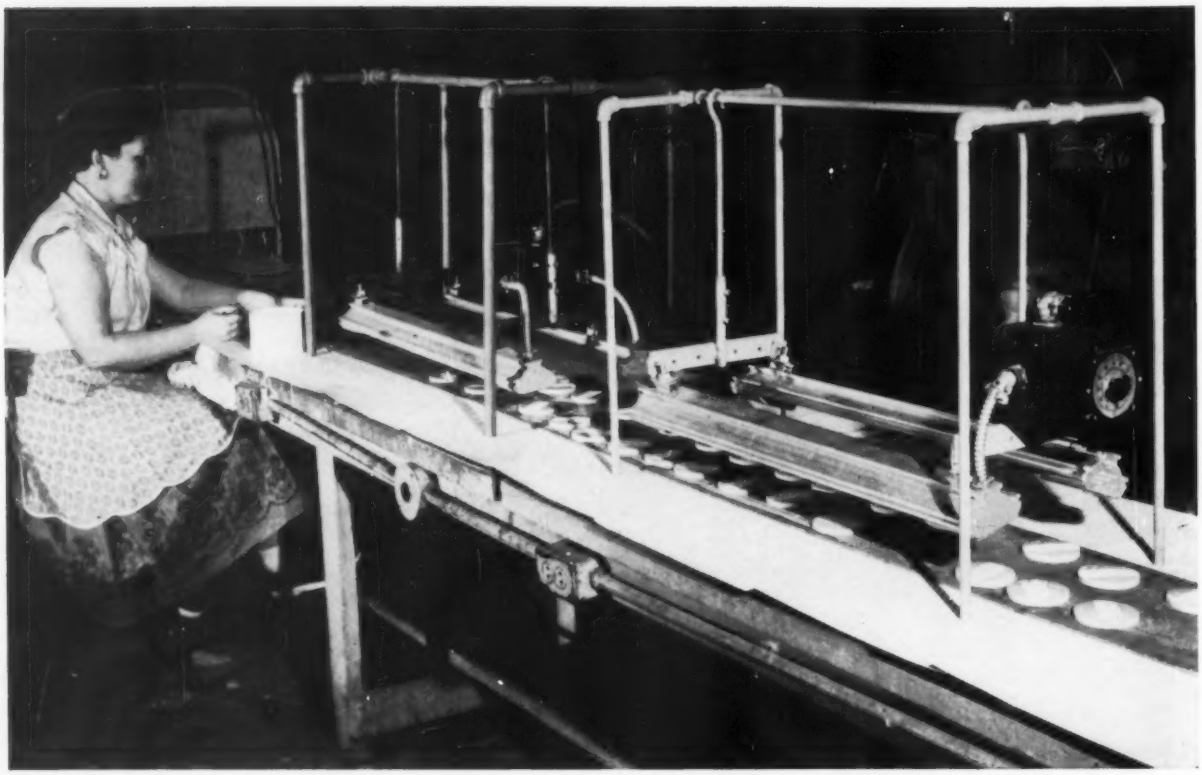
U.S.A. F. J. STOKES MACHINE CO. PHILADELPHIA 20, PENNSYLVANIA

CANADA WILMOND CO. PLASTIC DIVISION 2488 DUFFERIN STREET TORONTO



far-infrared heat . . . precisely controlled . . . solves problem of baking paint on plastic

Baking painted designs and lettering on plastic compact cases presented a tough production problem for this company. Too much heat blistered or melted the thermally sensitive plastic material. Too little heat wouldn't bake the paint properly. Added complications were the various bright colors involved.

Four "color blind" Chromalox far-infrared radiant heaters, having a total installed capacity of 7200 watts, provided the answer. The heaters are mounted lengthwise in pairs over the conveyor belt. The long wave length far-infrared radiation heats all colors with practically equal speed . . . and with negligible reflection even from white surfaces. Input controllers for each pair measure out the exact degree of heat required.

Results are rapid, uniform baking of the paint, regardless of the color. Stepped up production without damage to paint or plastic. Low initial investment, low operating and low maintenance costs of the lightweight, portable, all-metal Chromalox radiant heaters.

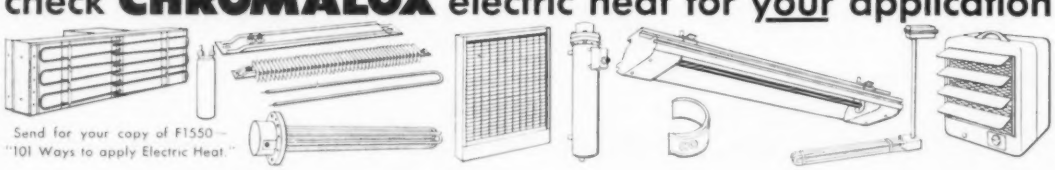
This problem-solution-result approach has enabled us to help many manufacturers produce better, faster, at lower cost.

Always available to you are our research, engineering, design and modern manufacturing facilities. The world's largest factory stock of industrial electric heaters plus local stocks at strategic points. And a 33-city nationwide sales-engineering service.

Let us know your problem for controlled heat and we'll go all out to help you find the right answer—electrically.

EDWIN L. WIEGAND COMPANY
7503 Thomas Boulevard, Pittsburgh 8, Pa.

check **CHROMALOX** electric heat for your application



Send for your copy of F1550—"101 Ways to apply Electric Heat."

Crosley

West Bend Aluminum

Du Pont

I. B. M.

Sylvania

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Revere Copper

Jack & Heintz

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Remington Rand

Westinghouse

Lewyt

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Dixie Cup

National Carbon

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Rochester Germicide

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Companies you can trust ...trust Norton

Norton Laboratories, Inc., Lockport, New York.
Fine custom compression and injection molding
Sales Offices: New York—175 Fifth Avenue;
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Detroit—3-167 General Motors Building

NORTON *Laboratories, Inc.*

COMPRESSION AND INJECTION MOLDING

INVESTIGATE THE MOSLO LINE BEFORE YOU BUY ANY PLASTIC MOLDING MACHINE

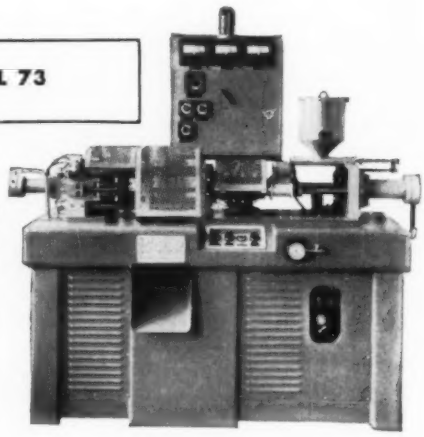
★ **HIGH SPEED** ★ **COMPLETELY AUTOMATIC** ★ **HYDRAULIC OPERATED**

Here is your answer to high-speed injection molding at a low mold cost. The completely redesigned Moslo line comprises three models: the No. 73, the No. 75, and the No. 80. Each is revolutionary in design—outstanding in performance. These machines are setting new and higher standards of quality production for many types of molding operations. They have the effective controls, rugged construction, reliability and speed that make profitable production possible, year after year, in all lines of the plastic molding industry. Savings extend to materials and mold cost as well as productive time.

A unique feature of the Moslo line is a simple and effective hydraulic system. All hydraulic valves are mounted on a convenient hydraulic manifold which eliminates 60% of the pipe fittings normally used in an injection molding machine. It simplifies maintenance problems and eliminates many potential oil leaks.

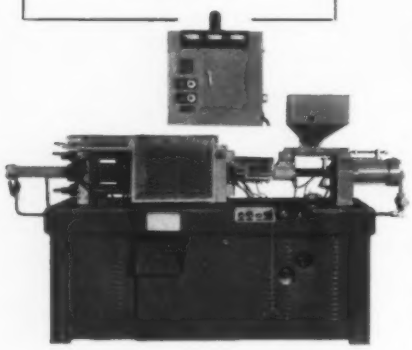
Before you buy any plastic molding machine, either fully automatic or hand operated, we urge you to investigate the features of the Moslo line. We invite your inquiry—write for additional information.

MODEL 73



- 2 oz. injection capacity per shot
- 1200 cycles per hour
- 25 lbs. per hr. plus plasticizing capacity
- Molds 20 square inches of area plus
- Material hopper capacity—40 lbs.
- Mold opening 6"

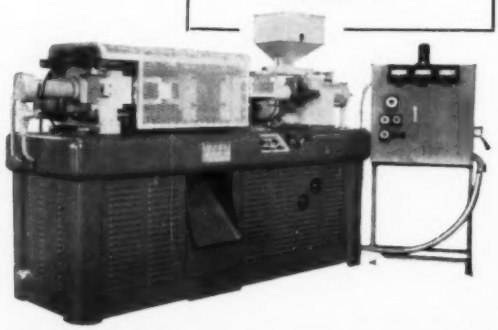
MODEL 75



- 3 oz. injection capacity per shot
- 740 cycles per hour
- 50 lbs. per hr. plasticizing capacity
- Molds 40 square in. of area
- 50 lbs. capacity of material hopper
- Deep draw at high speeds

This machine is available with mold arrangement and cycle to fit requirements of mold opening from 8 to 16 inches.

MODEL 80



- 4 plus oz. injection capacity per shot
- 780 cycles per hour (dry run)
- 75 lbs. per hr. plasticizing capacity
- Molds 60 sq. inches of area
- 60 lbs. capacity of material hopper
- Mold opening 8"

MOSLO MACHINERY COMPANY

2443 PROSPECT AVENUE • CLEVELAND 15, OHIO

Monsanto Plasticizer News

Flame Retardent...Non-Toxic Good Low Temperature Flex

SANTICIZER 141

FLAME RETARDENT

50 p.h.r. DOP

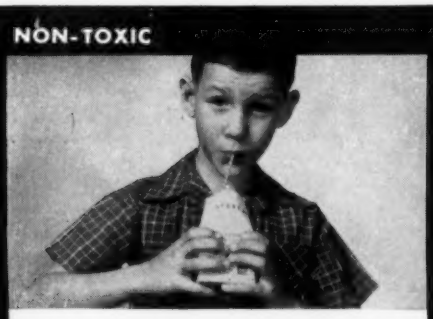
35 p.h.r. DOP
15 p.h.r. Santicizer 141

S.P.I. FLAMMABILITY TEST on 2 films shows superior flame retardance of vinyl containing Santicizer 141 plasticizer. Enables vinyl garment makers to comply with the 1954 Flammable Fabrics Act.

IN ADDITION—Santicizer 141 offers the same low-temperature flex as DOP, *plus* improved light stability, superior stain and oil resistance, and faster fusion and processing characteristics.

Santicizer: Reg. U.S. Pat. Off.

NON-TOXIC



SANTICIZER 141 has been fully approved by the Bureau of Animal Industry as a nontoxic plasticizer for use in vinyl products such as food containers, wrapping films, beverage tubing, packaging materials, etc., which are intended for contact with food items.

LOW TEMPERATURE FLEX IS EQUIVALENT TO DOP

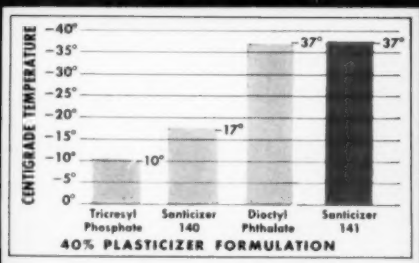


CHART SHOWS the flexibility Santicizer 141 imparts to food wrapping, paper coating, sheeting and film.

MONSANTO

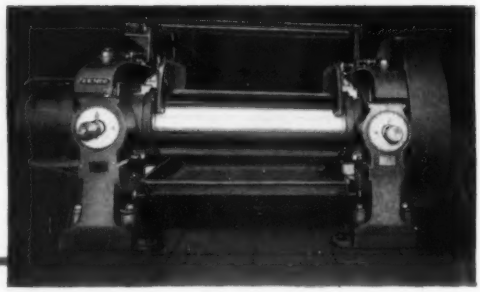
SERVING INDUSTRY WHICH SERVES MANKIND

FAST DELIVERY. For delivery when you are in need, Monsanto has bulk shipping stations located in strategic cities from coast to coast.

FOR MORE FACTS on Santicizer 141, write for technical Bulletin: Organic Chemicals Division, MONSANTO CHEMICAL COMPANY, Box 478-K-1, St. Louis, Missouri.

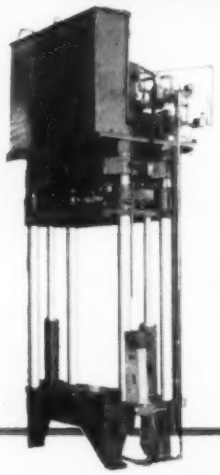
PLASTICS EQUIPMENT . . . designed . . . and built by ERIE ENGINE & MFG. CO.

PREFORM MACHINE. For making glass fiber preforms up to 100 sq. ft. Includes curing chamber for setting binder. Also available in sizes from 8 sq. ft. to 700 sq. ft.—with or without self curing feature.



MILLS FOR MIXING. 22″ x 60″ shown. Available in all sizes from 6″ x 12″ to 26″ x 84″.

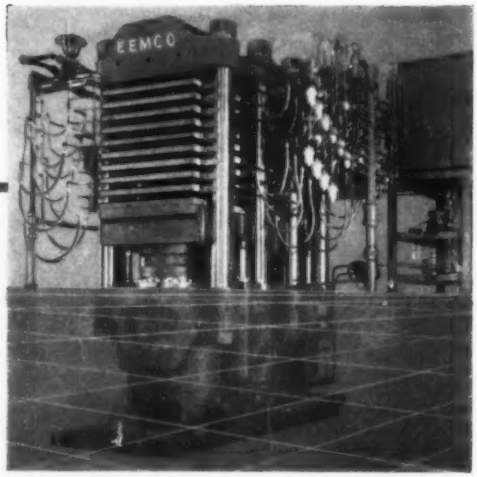
ROVING CUTTER. For cutting glass rovings in varied lengths for preforming.



60″ x 42″ Reinforced Plastics Molding Press—236 tons. Down acting, fast traverse. Available in all sizes from 12″ x 12″ to 84″ x 144″ and larger—either up or down acting.

42″ x 42″ SIDE PLATE PRESS—1300 tons. Other sizes from 20″ x 20″ upwards.

51″ x 123″ LAMINATING PRESS—3300 tons. Custom built to individual specifications in any size.



EEMCO

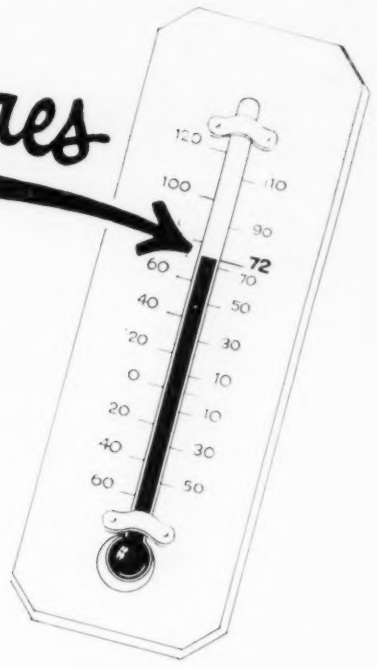
ERIE ENGINE & MFG. CO.

12th ST. & EAST AVE., ERIE, PA.

Mills • Presses • Loaders • Lift Tables • Platens • Preform Machines • Roving Cutters

Now–You can dissolve high molecular weight polyvinyl chlorides

at room temperatures



Du Pont TETRAHYDROFURAN gives high solids content at practical working viscosities

Tetrahydrofuran (THF) may be the key to a new or better selling product for you.

Here's an example. Adhesives made possible with THF have given manufacturers just what was needed to join PVC to PVC with a bond virtually as strong as the original materials. Result: new polyvinyl chloride products such as multi-purpose bags; a faster, easier way of joining plastic pipe and a stronger, better line of toys.

The unique solvent power and low boiling point of THF are opening doors to many other new and improved products. Fabric coatings, plastic sheet coatings, printing inks and lacquers are just a few. There will be many more.

If you think a powerful solvent for polyvinyl chlorides and other vinyl resins may help you improve your product or build a new one, we will be glad to send you more information about tetrahydrofuran. Just write: E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Dept., Wilmington 98, Delaware.

PHYSICAL PROPERTIES:

Appearance	Colorless, mobile liquid
Odor	Ether-like
Molecular weight	72.10
Freezing point	-108.52°C.
Boiling range	65-67°C.
Flash point (Tag closed cup)	6°F.
Vapor pressure, mm Hg. at:	
25°C.	176
45°C.	385
65°C.	760
Solubility	Miscible with water. Soluble in most organic solvents.

Du Pont can assure you prompt delivery of tetrahydrofuran in tank car quantities.

Mail coupon for more information

DU PONT
TETRAHYDROFURAN

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

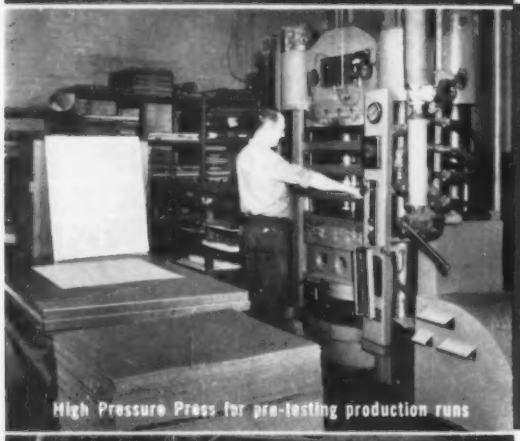
Please send me more information on tetrahydrofuran for use in the following applications:

_____
_____
_____
_____
_____

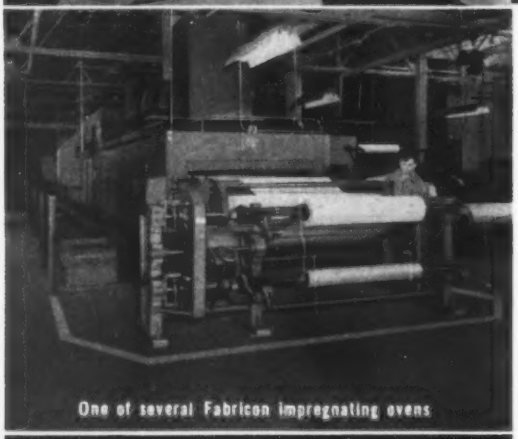
E. I. du Pont de Nemours & Co. (Inc.)
Electrochemicals Department MP-3
Wilmington 98, Delaware

Name _____
Position _____
Firm _____
Address _____
City _____ *State* _____

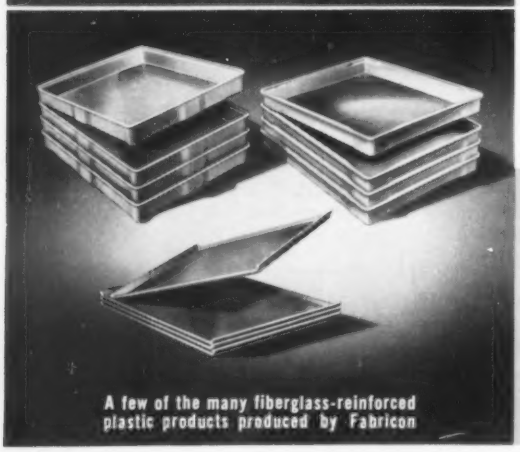
Fabricon's modern testing laboratory



High Pressure Press for pre-testing production runs



One of several Fabricon impregnating ovens



A few of the many fiberglass-reinforced plastic products produced by Fabricon

4 REASONS WHY it pays to ...call FABRICON

Yes . . . the 4 photographs tell their own story . . . give concrete reasons why it pays to do business with Fabricon! It's a story of painstaking control in everything Fabricon does for you . . .

- Laboratories for development of new products . . . for initial product testing . . . and for constant checks of production material to make sure quality is maintained!
- High Pressure Presses duplicate and pre-test your production runs, assure minimum production troubles in your factory!
- Modern impregnating ovens deliver impregnated materials within rigid specifications from run to run. Fabricon also offers you complete slitting, sheeting and die-cutting facilities . . . assuring you of lowest possible cost!
- A variety of products for satisfied customers spell vital know-how and experience at your disposal!

Large and small companies throughout the world have counted on Fabricon for over 14 years. Why not you?

FABRICON PRODUCTS

a Division of The Eagle-Picher Company

1725 W. PLEASANT STREET • RIVER ROUGE, MICHIGAN

Impregnating • Coating • Fiberglass Molded Products

PLANTS LOCATED AT: RIVER ROUGE, MICHIGAN • LOS ANGELES, CALIFORNIA

The boy with ideas...

THE NEW "DUTCH BOY" PLASTICIZERS	
Three Double-Duty Primary Plasticizers	
PRODUCT	**USED FOR —**
NL F-41	Outstanding low temperature flexibility Good low volatility
NL F-31	Excellent low temperature flexibility Good low volatility
NL F-21	Good low temperature flexibility Good low volatility
Four High-Purity Standard Plasticizers	
NL C-20 (Di-2-ethylhexyl Sebacate) **NL A-10** (Dibutyl Phthalate) **NL A-20** (Di-2-ethylhexyl Phthalate) **NL A-30** (Di-isooctyl Phthalate)	

You'll get ideas, too . . . once you see what "Dutch Boy" double-duty Plasticizers do for vinyls.

They're the "Dutch Boy's" newest idea . . . first primary plasticizers pre-balanced at the factory for control over *both* low temperature flexibility and low volatility at the same time. In vinyl film, sheeting, extrusions, plastisols and organosols, formulated to premium standards, they reduce cost.

Want *outstanding low temperature flexibility* plus good low volatility? "Dutch Boy" NL F-41 will give it to you. NL F-41 also imparts excellent hand and drape, good heat- and light-stability, low water extraction.

Want *good low volatility* while maintaining good low temperature flexibility? Use "Dutch Boy" NL F-21.

Want *excellent low temperature flexibility balanced with good low volatility* at moderate cost? Try "Dutch Boy" NL F-31.

...this time, it's double-duty plasticizers

Besides the three double-duty plasticizers, National Lead also makes four exceptionally pure, standard-type plasticizers. All seven conform to the high standards of the name you *know* for quality . . . "Dutch Boy."

A leader in stabilizers, too.

Twelve "Dutch Boy" Stabilizers have found their place at the top in vinyl production . . . Normasal for vinyl flooring . . . Tribase & Tribase E for electrical insulations . . . Plumb-O-Sil C for brightly colored translucent film . . . Dyphos for opaque, outdoor products . . . to name a few.

By teaming up these twelve "Dutch Boy" Stabilizers with the seven new "Dutch Boy" Plasticizers, you get a hard-to-beat group of chemicals. Write for detailed technical data . . . on your letterhead, please.

Dutch Boy CHEMICALS

*Reg. U. S. Pat. Off.

NATIONAL LEAD COMPANY
111 Broadway • New York 6, N. Y.
In Canada: **CANADIAN TITANIUM PIGMENTS LIMITED**
630 Dorchester Street, West • Montreal

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VACUUM FORMING MACHINES

$for Big $aving $and Profits!$

AUTOMATIC
60 × 90
MACHINE

A SIZE FOR EVERY NEED

All TWO-STATION Units

MODEL NO.	SIZE	PRICE
APM 30	30"x30"	$2,480.00
APM 40	40"x40"	3,680.00
APM 60	60"x60"	7,400.00
APM 90	60"x90"	9,480.00

FOB Our Plant, CHICAGO
(Blowers not included)

Another Abbott FIRST!

Sensationally Priced $9480.00
FOB Our Plant, CHICAGO

PATENTS PENDING

Why You Should VACUUM FORM!

1) Thousands of short runs (under 50,000 pieces) cannot afford the advantage of plastic due to costly molds. All these jobs can be vacuum formed with very small tooling charges.

2) Many items require yearly models. Injection molds cannot be amortized, consequently again your customer must turn away from plastics.

3) With vacuum forming you can run materials as thin as .005 (impossible injection jobs) or change thickness at will to suit your customer.

4) Actual plastic models drawn over wood, clay or plaster molds can be submitted to your customer within 48 hours after initial inquiry.

5) Displays and signs all have a short life, with yearly or earlier complete design changes. Vacuum forming is the only means to accomplish fast changes with inexpensive molds.

Guaranteed to be the Highest Production Vacuum Forming Machines on the Market
ABBOTT'S 2 Working Tables Afford DOUBLE Capacity

BOOTHS 665 and 667
National Packaging Exposition
Chicago, April 18-21

ABBOTT PLASTIC MACHINE CORP.

Sales Offices: 6322 North Clark Street, CHICAGO 26, ILLINOIS

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FOR "TOP DRAWER" SERVICE AND QUALITY...

SPECIFY *HEYDEN!*

SUPERFYDE®

(HEYDEN)

A solid polymer of formaldehyde characterized by an extremely low water content, high assay, low reactivity, low solubility, and high melting point. Useful in syntheses requiring formaldehyde, which are prevented or inhibited by traces of water.

CONTAINERS

Superfyde® Powder
Fiber drums, 250, 100, 50, 25 lbs.

PARAFORMALDEHYDE

(HEYDEN)

A solid source of formaldehyde, for manufacturing synthetic resins and as a catalyst for cold-setting adhesives. Also used in fungicides, deodorizers, and photographic chemicals.

CONTAINERS

Paraformaldehyde U.S.P. X
(Powder, Medium Powder, Flo-Granular)
Fiber drums, 250, 50, 25 lbs.

HEXAMETHYLENETETRAMINE

(HEYDEN)

Valuable to the synthetic resins industry in the curing of resins. Used as a chemical intermediate and as a hardening agent for casein, glue and other proteins; as a rubber accelerator; for explosives; for fuel tablets; in medicinals. As an amine, it finds use as a neutralizing or deactivating agent.

CONTAINERS

Hexamethylenetetramine Technical

Granular . . Multiwall paper bags, 75 lbs.; Fiber drums, 100 lbs.
Powder . . Multiwall paper bags, 50 lbs.; Fiber drums, 100 lbs.

Hexamethylenetetramine U.S.P.

(Methenamine U.S.P. Powder or Granular)
Fiber Drums, 100, 50 and 25 lbs.

FORMALDEHYDE

(HEYDEN)

Widely used in the production of phenolic, urea, melamine and resorcinol resins; for converting casein, glue and other proteins into plastic products. Increasingly important in manufacture of chemicals and fertilizers. Used in embalming fluids, disinfectants, fumigants, deodorants, and in the leather, fur, paper and textile industries.

CONTAINERS

Formaldehyde Solution N.F.

Tank car . . . . . 72,000 lbs.
Tank truck . . . . . 30,000 lbs.
Drums . . . . 475; 125; 90 lbs.
Carboys . . . . . 100 lbs.

37% Formaldehyde—Methanol Free

Tank cars . . . . 72,000 lbs.
Tank trucks . . . 30,000 lbs.

FINE HEYDEN CHEMICALS

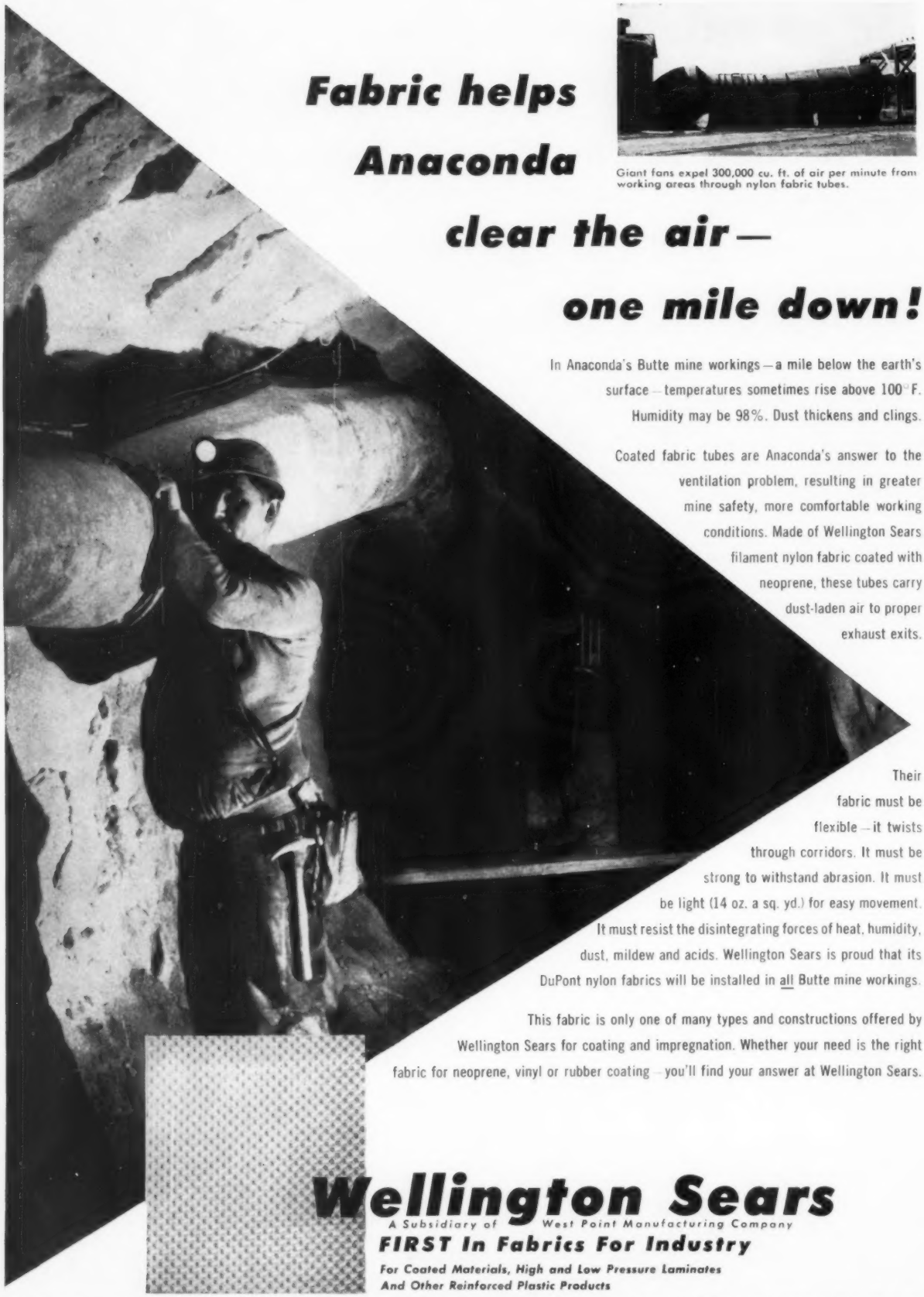
HEYDEN CHEMICAL CORPORATION

342 Madison Avenue, New York 17, N.Y.

CHICAGO • CINCINNATI • DETROIT • PHILADELPHIA • PROVIDENCE • SAN FRANCISCO

Fabric helps Anaconda clear the air — one mile down!

Giant fans expel 300,000 cu. ft. of air per minute from working areas through nylon fabric tubes.



In Anaconda's Butte mine workings—a mile below the earth's surface—temperatures sometimes rise above 100° F. Humidity may be 98%. Dust thickens and clings.

Coated fabric tubes are Anaconda's answer to the ventilation problem, resulting in greater mine safety, more comfortable working conditions. Made of Wellington Sears filament nylon fabric coated with neoprene, these tubes carry dust-laden air to proper exhaust exits.

Their fabric must be flexible—it twists through corridors. It must be strong to withstand abrasion. It must be light (14 oz. a sq. yd.) for easy movement. It must resist the disintegrating forces of heat, humidity, dust, mildew and acids. Wellington Sears is proud that its DuPont nylon fabrics will be installed in all Butte mine workings.

This fabric is only one of many types and constructions offered by Wellington Sears for coating and impregnation. Whether your need is the right fabric for neoprene, vinyl or rubber coating—you'll find your answer at Wellington Sears.

Wellington Sears

A Subsidiary of West Point Manufacturing Company

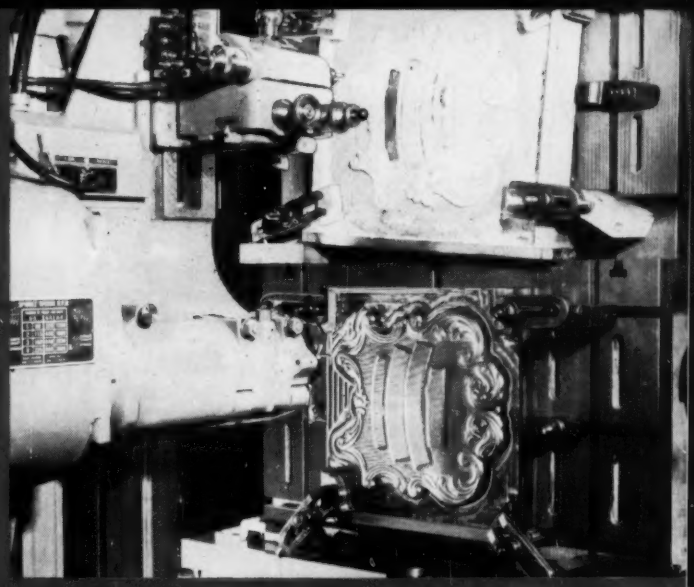
FIRST In Fabrics For Industry

For Coated Materials, High and Low Pressure Laminates And Other Reinforced Plastic Products

Wellington Sears Co., 65 Worth St., New York 13, N. Y. • Atlanta • Boston • Chicago • Dallas • Detroit • Los Angeles • Philadelphia • San Francisco • St. Louis

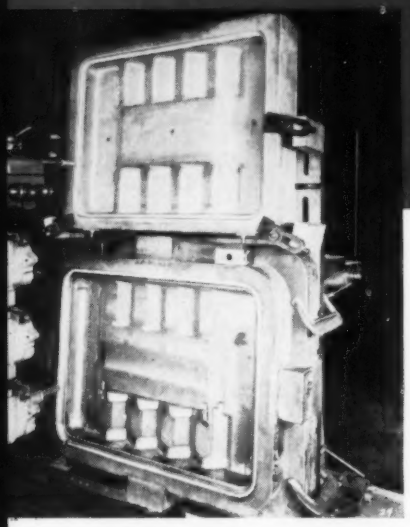
SPEED
PRECISION
economy

"KELLERING"



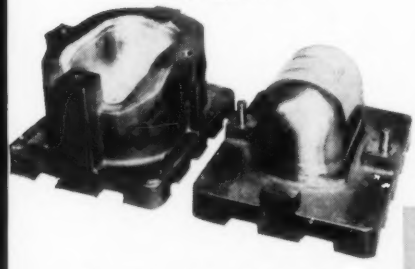
provides all 3 for all your

DIES and MOLDS



"Kellering" makes easy work of producing this big, complex meehanite cavity-half of a fiberglass mold.

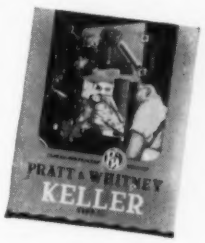
Photo courtesy of MPM Inc., Cleveland, Ohio



This mold and force for a fiberglass welder's helmet, duplicated from full models, included a deep cavity with heavy stock removal.

Photo courtesy of MPM Inc., Cleveland, Ohio

"KELLERING" . . . tracer-controlled milling with Pratt & Whitney KELLER Machines . . . accurately duplicates the shape of any simple or complex master form. Molds and dies of every type are produced with greater speed, ease, economy and accuracy than possible by any other method; hand finishing is reduced to a minimum. Designed specifically for tracer-controlled milling, versatile P&W Keller Machines are rugged, dependable, relatively simple . . . and ready to take on any of your toughest jobs without requiring major adaptation. The complete Keller line includes models to accommodate practically every work size. Efficient production of plastic products starts with the dies and molds . . . and Keller Machines will get you off to a better start. For complete information, write now on your Company letterhead for your copy of Circular No. 490-3 fully describing the Type BL Keller Machine.



PRATT & WHITNEY PRODUCTS FOR THE PLASTICS INDUSTRY

MACHINE TOOLS

Jig Borers
Rotary Tables
Jig Grinders
Vertical Shapers
Toolroom Lathes and Accessories
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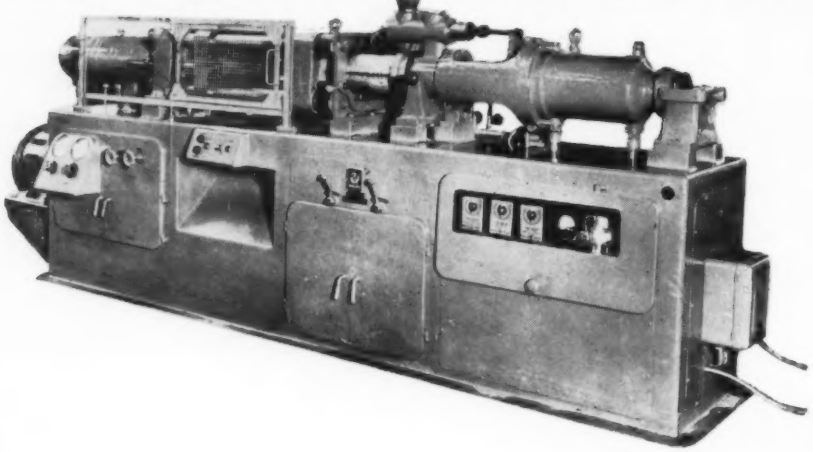

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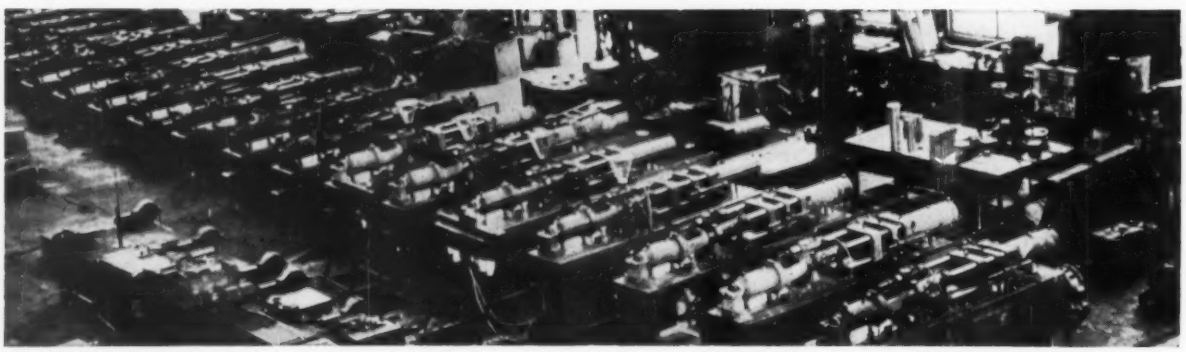

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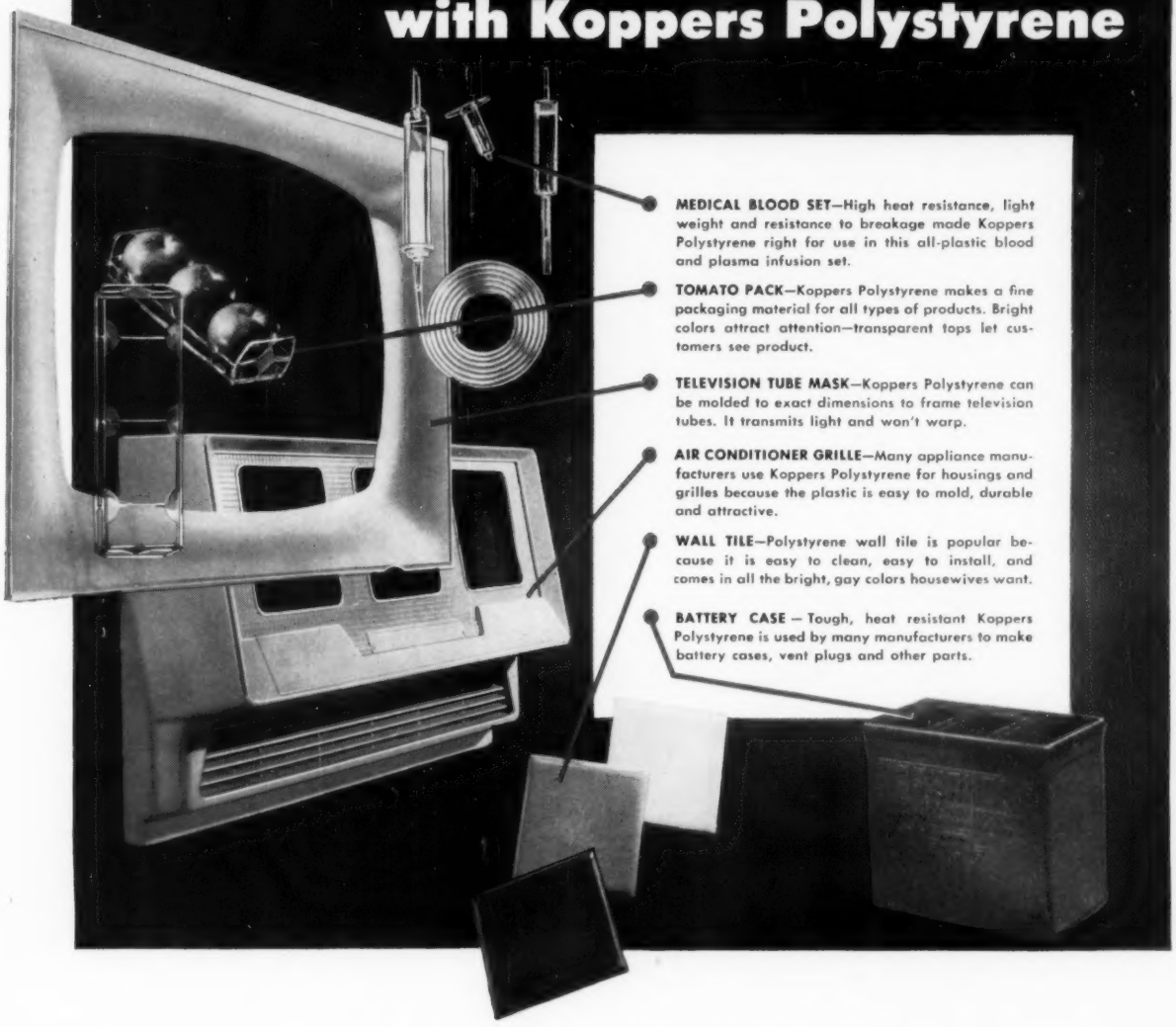

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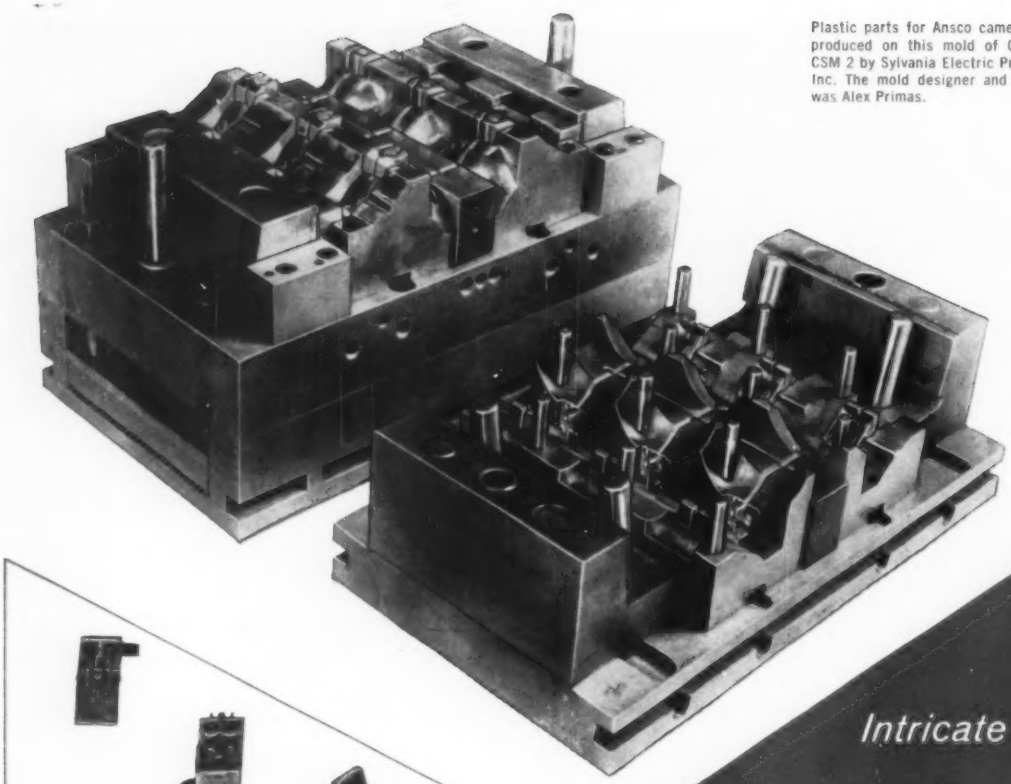

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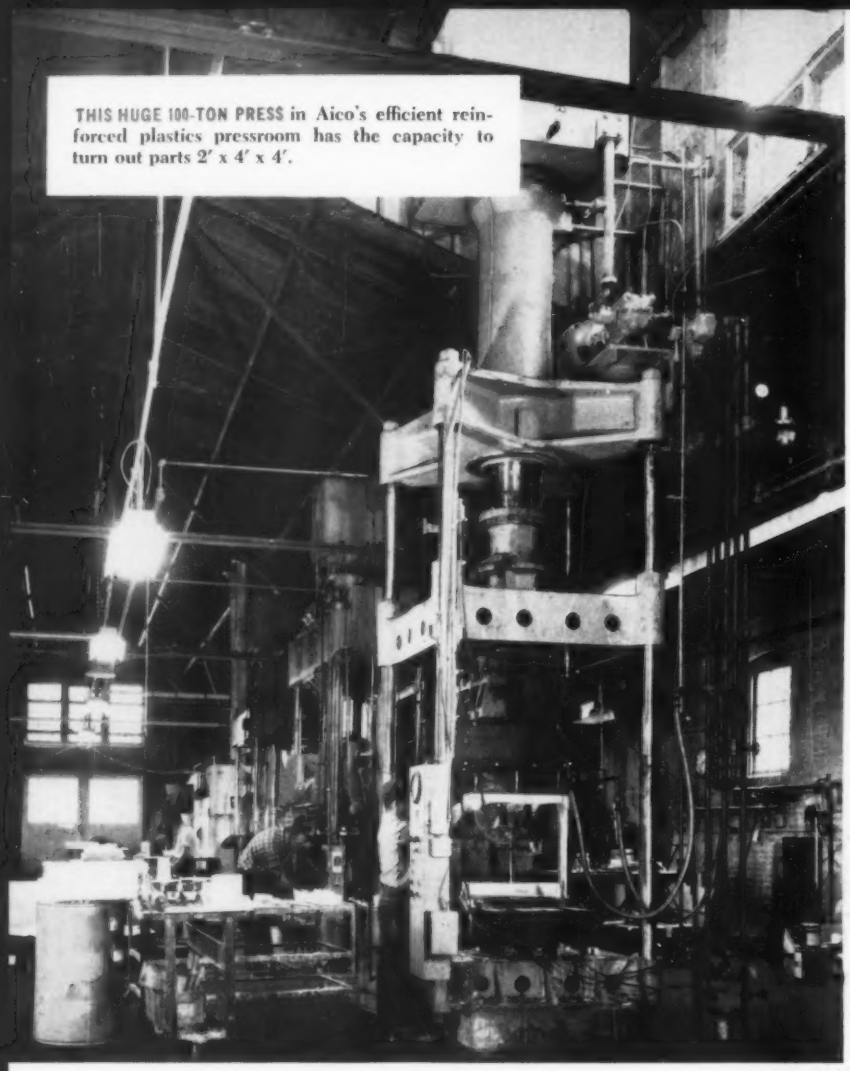

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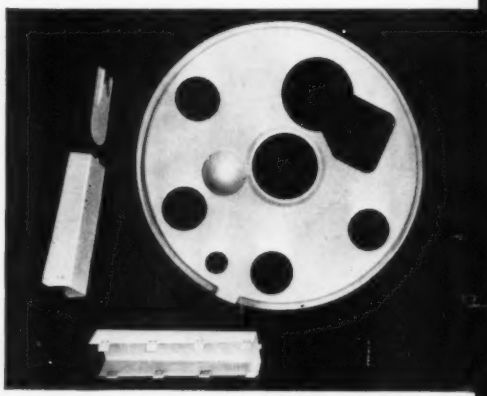

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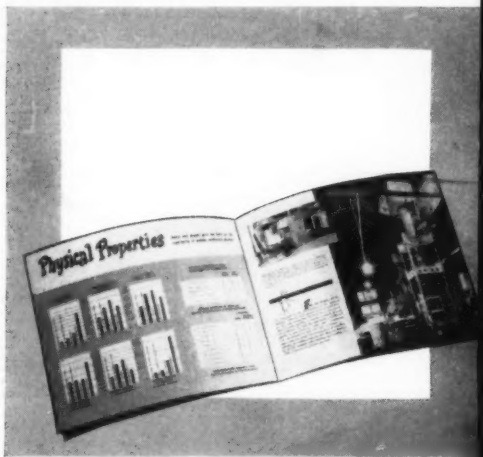

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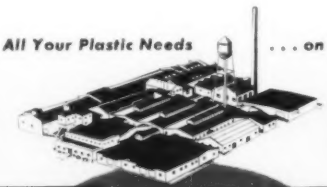
All Your Plastic Needs  *. . . on the Spot*

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MARCH 1955 VOLUME 32 NUMBER 7

The Atom—and Plastics

AT EVERY level of the Plastics Industry, from material maker to molder, processor, or fabricator, and at every level in every industry using plastics components, there runs today an uncertain and inquisitive excitement concerning a new form of energy—nuclear energy—directed toward plastics.

To a group of industries accustomed to the use of heat and pressure in the creation and application of organic materials, the concept of creation and/or adaptation by invisible and silent rays or particles is naturally exciting. The uncertainty is the result of much technical writing and very little lay presentation of established facts. The inquisitiveness is occasioned by worry that complete plants may be rendered obsolete or that great opportunities may be missed.

When a national publication states, as a magazine in the building field did last September, that "massive doses of gamma radiation have been harnessed to make an ordinarily soft sheet of plastic stronger than the same thickness of today's structural steel, and so resistant to heat that it could be used in the afterburners of jet engines," and when such wild statements are then retailed through the popular press, people interested in plastics are rightly concerned.

The simple facts are these: Nuclear energy is today an accepted tool for the transformation of one kind of plastic—polyethylene—from a thermoplastic to a thermoset polymer; it is a decidedly prospective tool for the polymerization of various existing monomers and the creation of new types of polymers and copolymers.

Reference to "nuclear energy" in the singular is vastly misleading. Bombardment for transformation or for processing of plastics materials may be by alpha particles, beta particles (electrons), gamma rays (like X-rays, pure electromagnetic energy), or neutrons—or combinations of these types of nuclear energy. The source may be a nuclear reactor, a shielded isotope, an electron generator, or an accelerator.

In addition, nuclear materials, such as isotopes, and nuclear methods are currently being used and are due to receive much greater use in wear testing, in the constant gaging of film thickness, and in other ways at quality control level.

At the core of this excitement is an element of natural secrecy on the part of the big chemical companies studying the polymerization possibilities of nuclear processing. And at the periphery is the uncertainty of the molder or processor. He is uncertain as to where he should begin his investigations, how much he should budget for a development program, what kind of equipment he should consider, what rental facilities may be available to him—and whether or not he should leave the whole matter in the hands of big and wealthy enterprise.

The editors of MODERN PLASTICS, being convinced that each reader of this publication, whether within the plastics industry or an executive of an end-user industry, cannot afford to plan for the future without studying this proposition, have gathered the facts on the nuclear approach to plastics and in the succeeding pages present them as simply and directly as presently possible. And all this is to the end that the excitement surrounding this subject may be relieved of its uncertainty and may have its inquisitiveness served.

This presentation is designed as a tool for management. Technologists may be bored, amused, or even irritated. But it is dedicated to the men who direct and decide. Every attempt was made, in the assembly of this composite feature, to secure the best advice from the most competent sources. The list of credits for cooperation on page 97 illustrates this approach.

Nuclear Primer

The atom, its parts, and its energies—and what these mean to plastics

ALL matter is composed of atoms. Each atom is composed of a nucleus containing protons ● and neutrons ○, around which electrons ●— rotate at terrific speed. The nucleus in comparison to the total size of the atom might be compared to a tennis ball suspended at the center of a sphere one mile in diameter.

A radioactive atom (found in nature in radium and polonium, for example) differs from a stable atom in that there is an imbalance of these three fundamental particles, and these unstable atoms are constantly trying to shake off the excess of one or the other of these three components in an effort to return to a stable state.

Take, for example, carbon-14, an unstable or radioactive atom. By ejection of an electron or beta "ray" or "particle" from this unstable nucleus, and other transitions, the radioisotope is changed into a stable atom of nitrogen-14, which contains seven protons and seven neutrons, around which move seven electrons.

By reverse process, if a nitrogen-14 atom is hit in its nucleus by a traveling neutron, it loses a proton and an electron and becomes unstable carbon-14.

All these fundamental particles or rays are components of nuclear energy. Without getting technical, the forms of energy involved are:

1) Alpha particles, α, which have very slow velocity, are big in size, and have little penetrating power. An alpha particle is composed of two protons and two neutrons.

2)Beta particles, β, which have tremendous velocity, relatively deep penetrating power and good ionizing ability. Beta particles and electrons are the same thing.

3) Gamma rays, γ, which are not particles but are true electromagnetic energy. Their velocity is the same as the speed of light. They have tremendous penetrating power and relatively small ionizing ability.

4) X-rays, which are similar to gamma rays but weaker.

5) Neutrons, n, of two kinds: fast neutrons and slow or thermal neutrons. Neutrons are available for bombardment only within an atomic pile or reactor.

Sources of Energy

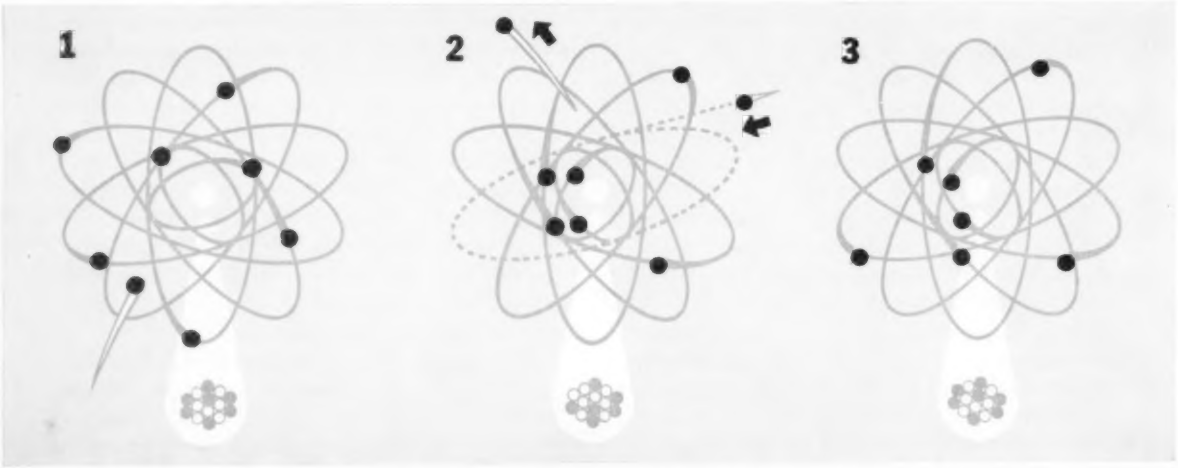
Of all these forms of nuclear energy, the two of greatest interest to the plastics industry are gamma rays and beta particles or electrons. They are important because they may be derived from isotopes or they may be generated by machines.

In addition to isotopes sources and generators, there is a prospective tremendous source of energy for irradiation in gross fission atomic waste which comes out of all AEC reactors or piles, and contain a great variety of radioactive isotopes.

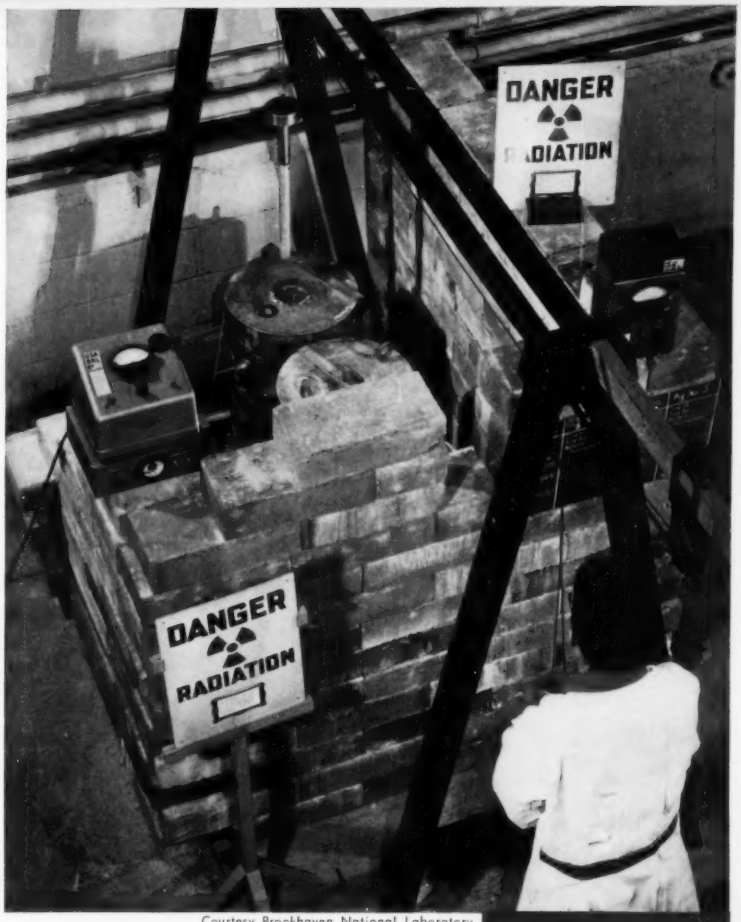
Different plastics in different states of polymerization react differently to different forms of nuclear energy. It appears possible that gamma irradiation, of ethylene at least, may be quite effective in polymerization; but beta or electron bombardment may be most effective in cross-linking a finished thermoplastic polyethylene material to make it a thermoset.

The selection of irradiation sources and tools to be used will depend on the type of enterprise in which each company is involved, the size of the enterprise, the kinds of plastic material with which it is working, its capital availability, its prospective markets, and its technical personnel.

Fortunately, various rental research irradiation sources are rapidly becoming available so that material may be shipped to a well-equipped facility for irradiation during the experimental stage, thus giving the plastics company time to thoroughly consider its probable plant radiation requirements.



Life cycle of a radioactive isotope: A stable nitrogen atom, made up of seven orbital electrons and a nucleus containing seven protons and seven neutrons, is hit by a neutron (1); it absorbs the neutron, loses one proton from its nucleus and one orbital electron, and is thus transmuted to radioactive carbon-14. The unstable carbon isotope emits a beta particle (electron) spontaneously and in that process changes one neutron to one proton (2), decaying back to stable nitrogen (3). The half-life of radioactive carbon-14 is approximately 6000 years



Courtesy Brookhaven National Laboratory

Fig. 1—Sample of material to be irradiated is lowered by remote control into "pig" containing high-energy gamma source. Brick wall around installation provides additional shield

Tools for Plastics Irradiation

Practical sources of radiation for bombardment include atomic piles or reactors, radioisotopes, and a number of electron-beam generators

NOW THAT the plastics industry knows it is possible to induce polymerization or copolymerization reactions in monomers by irradiation, without the use of high heats and great pressures, and without the use of catalysts, new and better plastics should eventually result.

Likewise, with the knowledge that cross-linking of polymers in plastics plants by irradiation can be accomplished—and if the process can be made safe and economically sound—better applications are probable.

A number of articles in this issue point up what has been done in these directions, give details of theory and procedures, and indicate future potentials. The present article is devoted to available facilities.

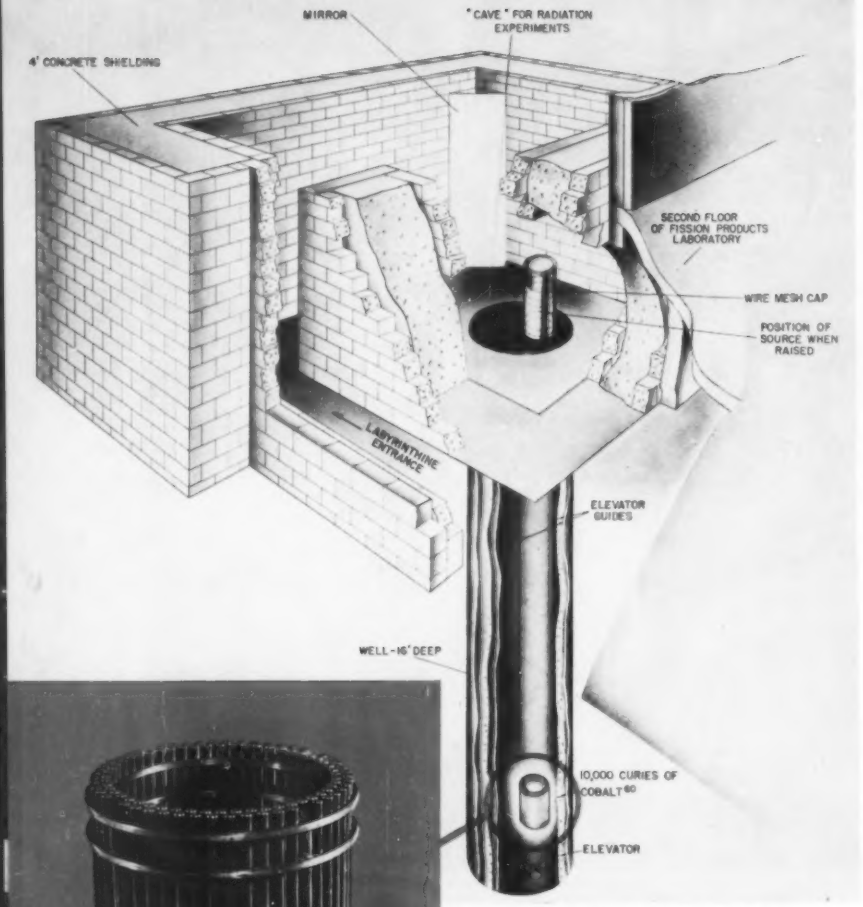
Piles or Reactors

For neutron bombardment there seems to be only one practical source: the atomic pile or reactor. Other types of rays are also generated in a reactor, but could probably be best obtained from other sources.

Reactors being developed by the AEC are designed for the production of power and can also find application in research and material bombardment. In addition, the construction of small research reactors (1 to 1000 watts) is planned by several industrial firms. According to Radiation Applications, Inc., a consulting firm in New York, several companies will give bids on these small reactors, including American Machine and Foundry Co., Babcock & Wilcox Co., Foster Wheeler Corp., General Electric Co., Kidde Nuclear Laboratories, North American Aviation, Inc., Nuclear Development Associates, Inc., Vitro Corp., and Westinghouse Electric Corp.

Isotope Facilities

Beta or electron radiation may be obtained either from a specialized



Courtesy University of Michigan

Fig. 2—Shielded room set-up for irradiation of large samples. Source consists of 100 rods of cobalt-60 (see inset) mounted in a circle

isotope source or from an electron generator machine. Gamma radiation can best be obtained in experimental quantity from a cobalt-60 isotope which has been produced by irradiating stable cobalt-59 in a reactor.

Cobalt-60 has a long half-life of 5.3 years, is readily available, and is relatively low in cost at $5 per curie. In decaying it turns to nickel in due course, giving off two gamma rays and a very weak beta particle.

Numerous facilities or shielded handling devices for radioisotope sources, including cobalt-60, have been developed.

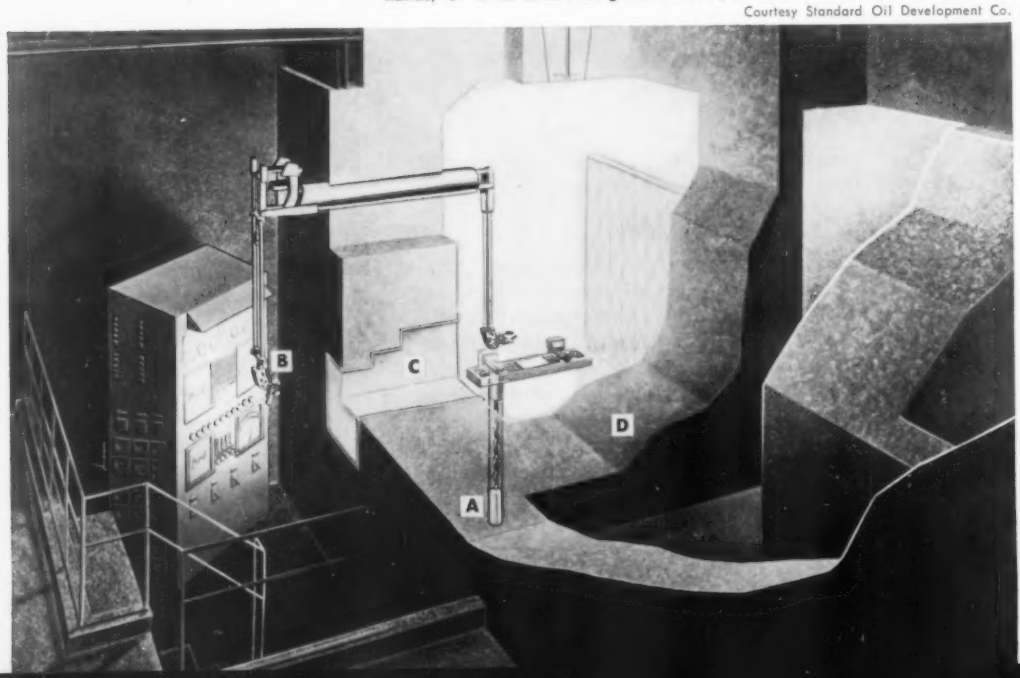
The Hollow Lead Pig—The first to be used and still one of the most popular is the thick lead pig. One at the University of Michigan is an almost solid lead cylinder about 2 ft. in diameter and 3 ft. high, with a 2-in. diameter hole down through the center. In this hole is placed a source tube of cobalt-60. Samples to be irradiated are loaded into the hole with remote control instruments and covered with a protective lid. At the end of some desired time the lid is removed, again by remote control devices, and the irradiated sample of plastic is taken out.

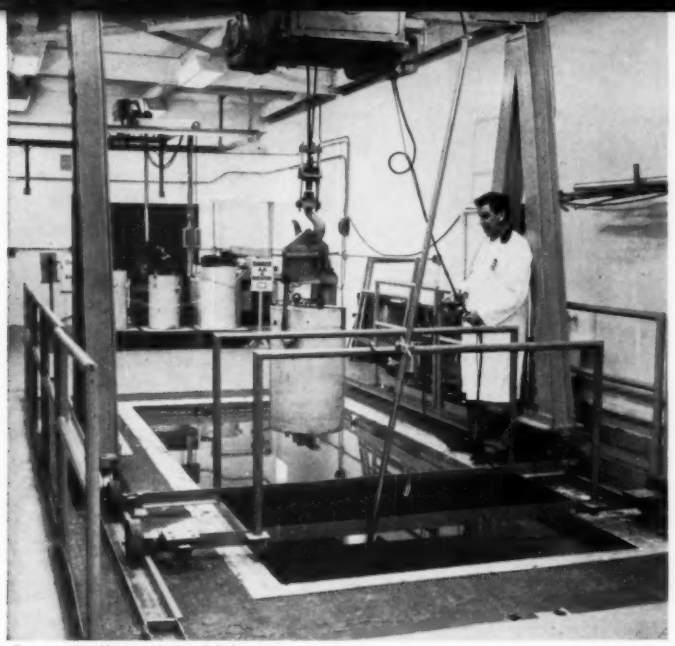
Figure 1 shows remote control loading at the "pig farm" at Brookhaven National Laboratory.

Shielded Rooms—When larger samples are to be gamma treated, it

Fig. 3—Sketch of proposed radiation "cave." A—radioactive cobalt "pipe" at bottom of storage well; B—one of two arms of remote control mechanical hands; C—3 ft. thick lead-glass window; D—concrete walls, over 4 ft. thick

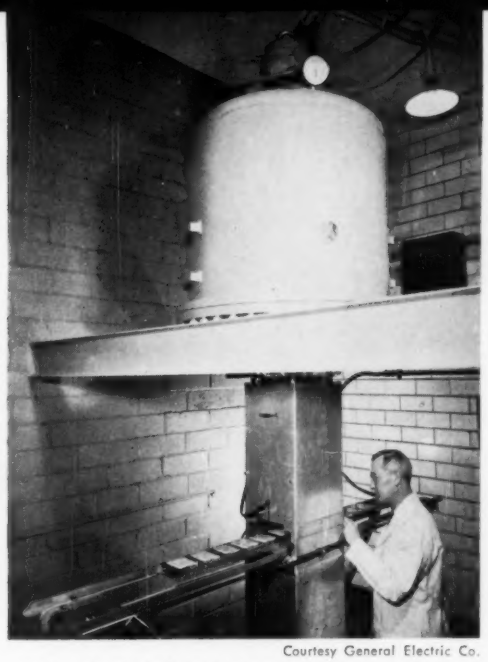
Courtesy Standard Oil Development Co.





Courtesy Brookhaven National Laboratory

Fig. 4—Gamma source of radiotantalum about to be lowered into "swimming pool." Deep water in pool provides effective shielding for operating personnel



Courtesy General Electric Co.

Fig. 5—Tank-shaped electron beam generator produces a stream of high-velocity electrons

may be necessary to use a shielded room. The University of Michigan uses for this purpose the facilities shown in Fig. 2. The source consists of 100 thin rods of cobalt-60 mounted in a circle about 8 in. in diameter. The rods are stored at the bottom of a 16-ft. well of water extending down from a concrete walled room. An advantage of this facility is that while the source is at the bottom of the well, radiation level in the room above is safe for humans so that people can move about to prepare polymerization equipment. As soon as personnel has left the room, the source is raised out of the well by an elevator and begins irradiating various chemicals placed around the top of the well.

In general, the shielded room is a thick-walled chamber containing a lead-glass or other protective window, also at least 3 ft. thick, and employing master-slave remote control manipulators to move the source from its protective housing into the area of the materials to be irradiated. Figure 3 shows the new "cave" or shielded room at the Esso Research Center in Linden, N. J., where the world's largest single cobalt source, a piece of pipe 13 in. long and 2 in. in diameter, which has been under irradiation at Brookhaven for over 2 years, will be used.

Water Pits or Canals—A third method of using a gamma source is the "swimming pool" or "canal," using "pigs" to deliver the source to the bottom of the pool.

The Brookhaven "swimming pool" is illustrated in Fig. 4, with a 1½ ton lead shield containing a gamma source of radioactive tantalum ready to be lowered into the pool. The deep water provides a convenient shield to protect the men who use remote control tongs to remove the source from the lead shield and place it on the bottom of the pool.

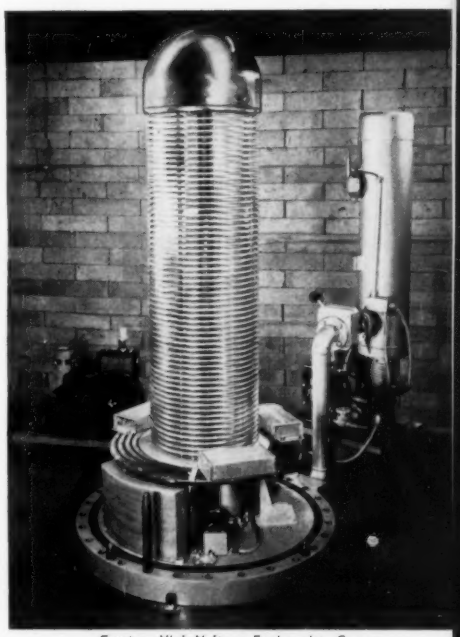
An advantage of the "swimming pool" is that large objects can be lowered into the pool and placed alongside of or be surrounded by the sources. Disadvantages are their high cost in water circulation devices and the need for special safety precautions.

It can be easily seen that these isotope irradiation source facilities are to-date strictly laboratory or pilot in size and scope. When industry comes to use isotopes or gross fission waste for irradiation of plastics on a mass-production basis, facilities will necessarily be fantastic in size, will involve conveyors, and will probably be terribly expensive—but will follow these same principles.

"Machines" for Irradiation

Latest work done on the cross-linking of polymers has been done with electron beam or beta generators. It is almost impossible to compare radiation machines with isotope sources from any standpoint. The type of rays required; the type, shape, and size of material to be treated; the rate of irradiation and output; flexibility; safety hazards; cost; and efficiency are all factors.

One great advantage of a machine is, of course, that it can be turned off, while an isotope source keeps on producing radiation. There are, in



Courtesy High Voltage Engineering Corp.

Fig. 6—Set-up of 2½-m.e.v. Van de Graaf accelerator, about 6½ ft. high

Glossary of Radiation Technology

The following list of terms has been compiled to provide simplified definitions of concepts and units in the field of atomic radiation. The list, by no means complete, includes only terms relevant to the articles on radiation and irradiation of plastics in this issue.

Alkene—Any hydrocarbon of the ethylene group, an olefin.

Alpha particle—A subatomic component, having two protons and two neutrons, identical to the nucleus of the helium atom. Alpha particles are relatively heavy and slow moving, have limited penetrating powers, can travel about one inch in air, are stopped by a thin sheet of paper.

Atom—The basic unit of all matter, consisting of a nucleus surrounded by rotating electrons. The arrangement of the nucleus and the electrons determines the element. At present, 98 elements have been identified.

Beta particle—Electron emitted by radioactive atom. Beta particles travel at great speed and have greater penetrating power than alpha particles. They can travel a few feet through air and penetrate a fraction of an inch into animal tissue.

Curie—Unit denoting an amount of radioactivity equivalent to the number of disintegrations per second in a gram of radium, i.e. 37 million disintegrations per second. A millicurie is one-thousandth of a curie, a microcurie is one-millionth of a curie.

Electromagnetic energy—Energy in the form of magnetic forces which are due to electric currents (e.g. radio waves, X-rays, etc.).

Electron—A subatomic particle with one negative electrical charge, which moves about the nucleus of an atom. Its negative charge equals the positive charge of the proton in the nucleus.

Electron volts—The amount of energy gained by an electron in passing from a point of low potential to a point one volt higher in potential. The unit generally used in radiation work is one million electron volts (m.e.v.).

Gamma ray—Energy waves emitted by some radioactive elements. Gamma rays have shorter wavelengths than X-rays; they have high penetrating power and can travel some distance through lead.

Ion—An electrified particle formed when a molecule of gas (as in air) loses an electron by the action of gamma or X-rays, or by the impact of alpha or beta particles.

Ionization—The process by which gas molecules are transformed into ions. Ionization can be used as a measure of radioactivity since the degree of ionization is a function of the degree of radioactivity.

Isotope—Any one of three or more forms of the same element, differing only in the number of neutrons contained in the atomic nuclei. All isotopes of a particular element possess the same chemical characteristics. An unstable isotope is termed a radioisotope and emits radiation.

Neutron—One of the parts of the nucleus of an atom. Having about the same mass as a proton, but no electric charge, it is used in atomic chain reactions and in bombarding stable atoms to produce isotopes.

Neutron flux—The stream of neutrons present in an atomic reactor as a result of splitting fissionable uranium.

Nucleus—The central core of an atom, consisting principally of protons and neutrons.

Proton—A heavy particle in the nucleus of an atom, with a mass approximately the same as that of a neutron and a positive electrical charge equal to the negative charge of an electron.

Roentgen—A measure of ionizing power, equivalent to the absorption of 83.8 ergs of radioactive energy in one gram of air.

rep—(roentgen equivalent, physical). The amount of radiation energy which produces an absorption of 83.8 ergs in one gram of tissue or water. Plastics are often considered as water for purposes of determining rep.

addition, technical difficulties in handling large isotope sources, shipping and storage being major problems, and there must always be safeguards against radiation. Maintenance of conveyors and other auxiliary apparatus in the vicinity of the irradiation source would be more complex and costly than in the case where the irradiation source can be turned off completely.

The electron beam from a generator is a stream or shower of subatomic particles whose nature is the same as electric-wire current except that the electrons have been liberated from the conductor and accelerated to tremendous speeds.

Electron Beam Generators—The following information on an electron beam generator was supplied by the X-ray Dept. of General Electric Co., Milwaukee, Wisc., and refers specifically to the unit illustrated in Fig. 6. Basically, this tank-shaped unit contains the electrical elements necessary for producing high-velocity electrons. It is, by virtue of its resonant transformer (one peaked or tuned to give maximum efficiency) and gas-type insulation (as opposed to oil insulation), a relatively lightweight, compact, high-output electron beam source, with no moving parts to create service problems and cause frequent breakdowns.

When the unit is switched on, a beam of electrons pours out of the "window" or target end of the unit. The beam ceases when the switch is opened. Output can be controlled and modified at will.

A not infrequent question asked by those familiar with the outward appearance of G-E's 1,000,000-v. X-ray equipment is: "Why is there such a similarity in the appearance of this supervoltage X-ray unit and the G-E Electron Beam Generator?" The answer is that they are basically the same unit.

An electron beam already exists inside all X-ray equipment. But in an X-ray tube, the beam spends itself bombarding a tungsten target internally, which produces X-rays.

The unique design of G-E's 1,000,000-v. X-ray machine suggested to its engineers that a few modifications, along with the removal of its tungsten target, would result in an exceptionally efficient electron beam generator. These changes were car-

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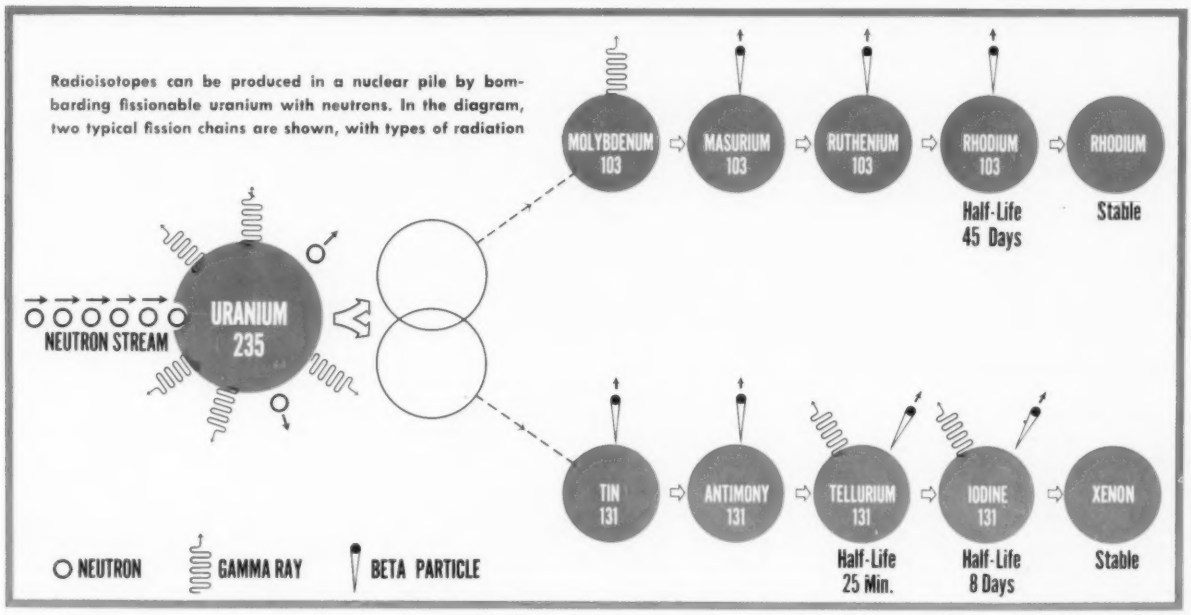
ISOTOPES

What they are and how they are used



THANKS to nuclear energy, the plastics industry now has a series of powerful tools with which to accomplish things undreamed of only a few years ago. And of the several sources of nuclear energy available to the plastics industry, radioisotopes probably constitute the most versatile. Through their use, there are in prospect new materials, greatly improved processing techniques, and basic research into a growing area of monomeric and polymeric problems.

Some of the accomplishments attained through the use of radioactive isotopes are described below. But these are only very early results of plastics' cautious venturing into the whole realm of atomic energy. They only suggest the vast potential of uses in the plastics field of high-energy radiation from various sources.

As companies experiment with these new energy sources, ever-increasing areas of application will be found. At the same time, the limits of the radioactive technique will become clearer. That there are such

Table I—Half-Life and Type of Radiation of Some Common Isotopes

Isotope	Half-Life		Beta	Gamma
			m.e.v.	m.e.v.
Carbon 14	6000	years	0.154	none
Nickel 63	63	years	0.06	none
Strontium 90	25	years	0.537	none
Cobalt 60	5.2	years	0.31	1.17, 1.33
Iron 55	2.91	years	K capt.	none
Antimony 125	2.7	years	0.128, 0.299, 0.616	7 gammas, $0.035 < E_\gamma < 0.637$
Cesium 134	2.3	years	0.090, 0.658	0.568, 0.602, 0.794, ~1.35
Calcium 45	180	days	0.254	none
Sulphur 35	87.1	days	0.167	none
Iron 59	46.3	days	0.26, 0.46	1.1, 1.3
Cadmium 115	43	days	1.67	0.5
Phosphorus 32	14.3	days	1.712	none
Barium 140	12.8	days	0.48, 1.022	0.540, 0.306, 0.160
Bismuth 210	5	days	1.17	none
Arsenic 77	40	hours	0.7	none

Table II—Suppliers of Radioisotope-Labeled Chemicals

Abbott Laboratories
Oak Ridge, Tenn.

BioRad Laboratories
800 Delaware St.
Berkeley, Calif.

Bjorksten Research Laboratories
323 W. Gorham St.
Madison 3, Wis.

Fisher Scientific Co.
711 Forbes St.
Pittsburgh, Pa.

Isotopes Specialties Co.
3816 San Fernando Rd.
Glendale, Calif.

Jasonols Chemical Corp.
1085 Myrtle Ave.
Brooklyn 6, N. Y.

National Bureau of Standards
Washington 25, D. C.

Nuclear Instrument & Chemical Corp.
223 W. Erie St.
Chicago 10, Ill.

Nuclear Research Corp.
2563 Grays Ferry Ave.
Philadelphia 46, Pa.

Carbide & Carbon Chemicals Co.
Oak Ridge National Laboratory
P. O. Box P
Oak Ridge, Tenn.

Radioactive Products, Inc.
443 W. Congress St.
Detroit 26, Mich.

Research Specialties Co.
1148 Walnut St.
Berkeley, Calif.

Schwarz Laboratories
230 Washington St.
Mt. Vernon, N. Y.

Texas Research Foundation
P.O. Box 43
Renner, Texas

Tracerlab, Inc.
130 High St.
Boston, Mass.

limits has already been established; exactly what they are remains to be seen.

What Are Isotopes?

Atoms of any one of the 98 known elements are not necessarily all identical, but may differ from each other in the number of neutrons in their nuclei. (See Nuclear Primer, p. 84, for brief description of composition of atoms and glossary, p. 88, for definitions of terms.) Atoms of the same element having varying amounts of neutrons will vary in weight and other physical properties, while being chemically indistinguishable from each other.

Atoms of the same element, but with different atomic weights, are called isotopes. Every element has at least three possible isotopes. Some have over 20.

The element carbon, for example, has been identified in the form of five isotopes. Each carbon atom contains six protons and from four to eight neutrons.

Isotopes are designated by the chemical symbol of their element, followed by the sum of the number of protons and neutrons contained in each atom (atomic mass). In the case of carbon (C), C^{10} represents a carbon isotope having six protons and four neutrons per atom; C^{14} is the symbol for a carbon isotope with six protons and eight neutrons per atom, etc.

Isotopes occur naturally or they can be man-made; they can be stable or radioactive. Of the over 1000 isotopes identified to-date, over 700 are radioactive. The type that is of primary, though not exclusive, interest to various phases of work in the plastics industry, is the man-made radioactive isotope.

Man-made radioisotopes are produced by bombarding stable atoms with atomic nuclear particles, primarily neutrons. During this bombardment, the equilibrium of the stable atom is disturbed. As a result, the stable atom develops a tendency to rearrange itself in order to eliminate the excess energy absorbed while being bombarded. During this process, the atom discharges energy in the form of radiation until it has lost its radioactivity and once more has become a stable atom. This process is called decay.

As a radioisotope, an atom may radiate beta particles; a combination of beta particles and gamma rays; or, in rare instances, alpha particles.

Half-Life of Isotopes

The rate at which isotopes discharge their energy is the same for each type of isotope but varies from one type of isotope to the next. The rate of discharge is the isotope's "half-life," or the time it takes for one half of its radioactive energy to be dissipated. Iodine-131, for example, has a half-life of 8 days. That means that after 8 days, half of the radioactivity of radioiodine-131 will have been expended; after an additional 8 days, the remaining energy will again have been reduced by half (leaving 25% of the original energy); in 8 more days only 12.5% of original energy will remain, etc.

Differences in half-life are among the important factors that determine the use to be made of any particular radioisotope. Others include type (alpha, beta, or gamma) and strength (in curies, millicuries, or microcuries) of radiation. A radioisotope that is to be used as a beta ray source in a gaging instrument, for example, should have (among other characteristics) a relatively long half-life. On the other hand, a radioisotope-tagged chemical for use in tracing the dispersion of a pigment in a paint formulation should preferably have a shorter half-life, or a quite weak emission strength (see Table I).

Isotope Production

While radioisotopes have been produced by nuclear bombardment from naturally radioactive isotopes and by bombardment in particle accelerators, the source for most radioisotopes used today is the nuclear reactor.

When an atom of fissionable uranium is bombarded by neutrons in an atomic pile, it splits into two new radioactive atoms which in turn change into others. These are called fission products and make up a wide variety of radioisotopes. After the uranium slug is removed from the reactor, the fission products are chemically separated and become available as radioisotopes. Radioisotopes thus produced include strontium-90, iodine-131, and cesium-137.

The variety of useful isotopes that can be made in this fashion is lim-

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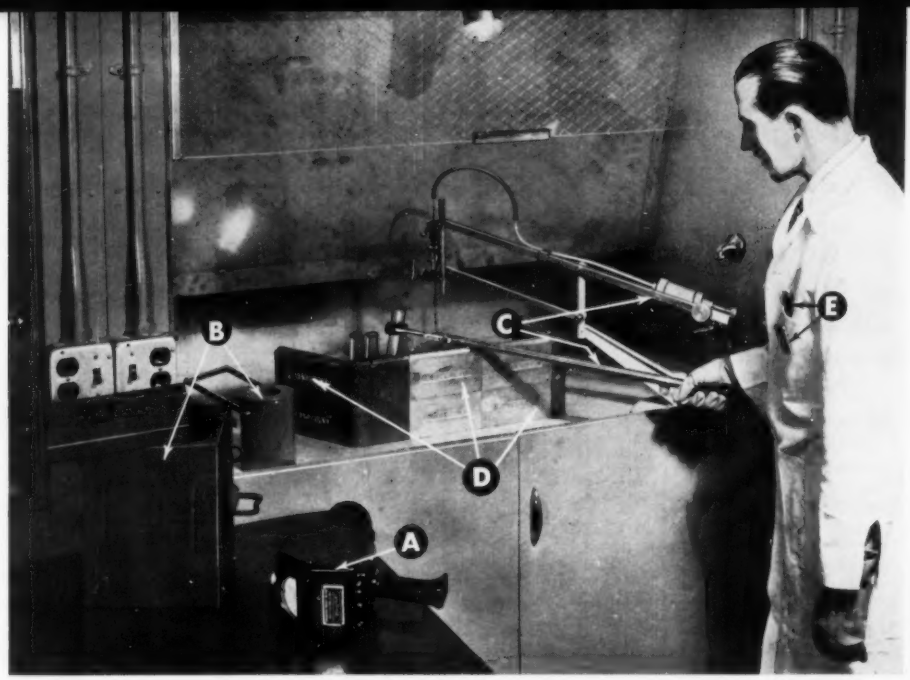

Instrument set-up for a "hot lab." A—survey meter; B—lead containers for isotopes; C—remote control handling equipment; D—lead bricks for shielding purposes; E—film badge and dosemeter for protection of operating personnel

A Plastics Radioisotope Lab

What you need, what it costs, and how to set it up

THE questions which arise when a company plans to set up a radioisotope laboratory are being asked with increasing frequency as more and more plastics firms are beginning to use this new tool of science. To the pleasant surprise of some of the questioners, the answers are fairly simple and the equipment is quite inexpensive.

Basically, a radioisotope laboratory is a chemical lab with a few special features and some unique devices. It is generally divided into three sections: one in which the chemical processing and most of the laboratory utilization of the radioisotope takes place; one in which experiments involving small amounts of radioactive material are carried out and in which samples are prepared for measurement; and one in which the measurement of the radioactivity of the samples takes place. The first two sections may be combined in one room if the total amount of radioisotopes handled is not very large and may even be confined to one corner of a larger chemical laboratory if the project is a very modest one. The third section, however, should always be well separated from the other two, for reasons which are dealt with in the following discussion.

The room in which radioisotopes

Automatic counting set-up for radioisotope research; automatic sample changer is at left; results are recorded on tape at right

All photos courtesy Tracerlab, Inc.

TABLE I—Equipment Requirements for a Radioisotope Lab

EQUIPMENT	RADIOISOTOPES						Approx. Cost
	Microcurie			Millicurie			
	alpha and soft beta	hard beta	gamma	alpha and soft beta	hard beta	gamma	
Controlled atmosphere hood				x	x	x	$500 and up
Absorbent paper or strippable paint on working surfaces	x	x	x	x	x	x	
Sensitive contamination monitor	x	x	x	x	x	x	$300
Simple remote handling tools					x	x	$150
Light shielding (¼-in. Plexiglas, etc.)					x		$10
Dosage rate monitor					x	x	$300
Film badges for measuring personnel exposure		x	x		x	x	$2/wk.
Movable heavy shielding (lead bricks, etc.)						x	$150
Shielded storage containers						x	$200
Personnel exposure dosimeters						x	$200
Separate waste collection containers				x	x	x	$10
Protective clothing (shoe covers, separate lab. coats, etc.)				x	x	x	$50

Semi-automatic counting set-up for use with radioisotopes. Instrument at left is a semi-automatic scaler. A manual sample changer is at right

are processed is called a "Hot Lab." It generally resembles an uncluttered chemical laboratory with the addition of devices which are designed to minimize the two problems associated with the use of radioisotopes: prevention of excessive radiation exposure and of radioisotope contamination. The seriousness of these problems is related directly to the amounts and types of radioisotopes to be used in the laboratory. Generally, the types of radioisotopes can be divided into three groups and the amounts into two classifications for the purpose of discussing the equipment and facilities required for handling them.

First there are those isotopes which emit only alpha or weak beta radiation, such as carbon-14 which is most frequently used in organic chemistry problems of plasticizer migration, polymerization, etc. These isotopes are hazardous only if ingested, so that the precautionary measures which have to be taken are limited to devices which prevent accidental inhalation of the material and which prevent and detect contamination. For microcurie amounts (the smaller of the two quantity classifications) this means that only a sensitive contamination monitor is required. For millicurie amounts a closed system hood, a separate container for waste material, and perhaps a respirator are needed if the material is volatile.

The second group of isotopes are those emitting energetic beta particles but no gamma radiation, such as strontium-90 which has been used as a source for studying the effect of irradiation on plastics surfaces. Here there is some potential danger of surface exposure to personnel, in addition to the problems associated with the first group, so that some remote handling equipment, external controls on the hood, some light shielding, and instrumentation for checking dosage are required for millicurie quantities.

The third group of isotopes includes all gamma emitters, such as cobalt-60 which, for example, has been used in the studies of the effect of irradiation on polymerization. These isotopes could cause excessive personnel exposure if they were used in millicurie quantities without some lead shielding, remote handling equipment, external hood controls, and instruments for checking dosage and personnel exposure.

Table I summarizes the above discussion of the items which are required in a radioisotope handling laboratory in addition to the normal chemical facilities. The equipment associated with the microcurie amounts of material would generally be that which would be used in the "Medium Activity Room" if this facility is separated from the "Hot Lab." Frequently, the "Hot Lab" can be eliminated entirely if the radioisotopes are purchased from a commercial supplier in the form in which they are to be used in the experiment.

The other part of the radioisotope laboratory is the "Counting Room" where physical measurements are made on the radioisotope samples.

This room should definitely be separate from the other sections of the isotope laboratory, and should be as far removed as possible from the "Hot Lab" if millicurie amounts of gamma emitters are handled or stored in the latter.

Counting Equipment

No special facilities are required in the "Counting Room" and, in fact, the counting equipment can be set up in a part of a regular laboratory. However, it is desirable that no heavy-load electrical equipment be operated on the same line as the measuring instruments since these are usually somewhat sensitive to sudden large voltage changes. Air-conditioning is also recommended in areas which have a relatively humid climate, because excessive moisture can cause malfunctioning of some of the sensitive detectors.

There is available a large number of instruments for the measurement of radioactive samples. Any selection must be based on the types and number of samples to be assayed, and on the technical level of the personnel making the measurements. For ease in analyzing the choice, the types of samples can be divided into those emitting alpha radiation, those emitting soft beta radiation, those emitting hard beta radiation, and those emitting gamma radiation. Different detectors are most suitable for each of these types. However, all the detectors can usually be operated with the same counting instruments (scalers or ratemeters). The selection among the counting instruments is based on a choice of completely manual, semi-automatic, or fully automatic equipment. The semi-automatic units usually are the best choice for a new laboratory since they are the easiest to operate and since they can generally be adapted later to fully automatic operation.

TABLE III—Approximate Scaler Prices

Type of Scaler	Features	Approximate Price
Basic manual scaler	Scaling factor of 100 or 256; electromagnetic register; separate timer	$450 including timer
Semi-automatic scaler	Scaling factor of 1000 or 4096; electromagnetic register; built-in timer, preset count, or preset time	$600 to $800
Automatic scaler	Scaling factor of 1000 or 4096; electromagnetic register; built-in timer, preset count, and preset time; provisions for amplifier; etc.	$1200
Automatic sample changing accessories	Provisions for inserting samples automatically into counting position and for printing data obtained by scaler	$1600 to $2500
Ratemeter	Choice of scale ranges and time constants approximately ±2% accuracy	$600

TABLE II—Approximate Radiation Detector Prices*

	Geiger	Proportional (including amplifier)	Scintillation (including amplifier)
Alpha radiation		$500 with window $650 windowless	$350 with window[a] $600 windowless
Soft beta radiation	250 with window 450 windowless[a]	$500 with window $650 windowless	$3500 for liquid scintillation counting
Hard beta radiation	250[a]	$500	$550
Gamma radiation	300 for solid samples 500 for liquid samples		$600 for solid samples[a] $900 for liquid samples

* Including shielded sample holder.
[a] Detector most commonly used for measuring this type of radiation.

Detectors

Alpha radiation by itself, in the presence of any other radiation, can be detected by a scintillation counter with a zinc sulfide (silver-activated) crystal or by a proportional counter, either of which should have a very thin window or preferably no window at all. An alpha scintillation detector is a much simpler device than a proportional counter.

Soft beta radiation can best be measured by a windowless Geiger-Mueller counter or a windowless proportional counter. The Geiger counter is both simpler and less expensive, but if a given sample contains a large amount of activity a proportional counter would be required since it can count at a much faster rate. For some specialized work with very low levels of activity, a liquid scintillation system,

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Polymerization

THERE is no dearth of technical literature on the effects provided by gamma irradiation of chemical compounds. David S. Ballantine, writing in the Technical Section of MODERN PLASTICS in November, 1954, listed many references to work done in that area.

The trouble is that some non-technical writers have erroneously interpreted scientific data in the literature and drawn some wild and dramatic conclusions—especially where they have assumed that if a little irradiation is good, a lot would be excellent.

For the person who is not an expert in the field, we shall indicate some of the probable chemical changes which occur when organic compounds, such as highly polymerized alkenes, are subjected to irradiation by gamma rays, and the physical changes associated with such chemical ones. We shall also attempt to analyze the economics of prospective gamma polymerization processes for ethylene.

Experimental evidence indicates that in some plastics certain properties may be changed by gamma irradiation in ways which are desirable; in other cases, too much irradiation destroys the plastic material. All organic materials decompose at elevated temperatures and it follows, therefore, that no treatment with gamma irradiation will yield products which would retain any desirable properties at high temperature levels.

Gamma Rays and Chemical Bonds

Gamma irradiation within the energy range used for chemical reactions does not induce radioactivity. Its principal effect in the case of organic compounds is one of cleavage of chemical bonds with the formation of free radicals. Because of the high energy and penetrating power of a gamma ray, it can pass through thick layers of organic substances, producing many radicals or fragments of molecules during its passage. Once these free radicals have been produced, they then undergo chemical changes which are typical of free radicals regardless of how they are made.

Figure 1 illustrates what might happen when one carbon-to-carbon bond or one carbon-to-hydrogen bond of hexane, a six carbon compound, is broken by a gamma ray. In the illustration, a two-carbon radical and a four-carbon radical are assumed to be formed, although the breakage of hexane into a one-carbon radical and a five-carbon radical or of two three-carbon radicals is just as likely. Carbon-to-hydrogen cleavage in hexane could produce three different groups, depending upon which hydrogen was removed, but only one of these is indicated in the illustration.

Many organic high polymers consist of long chains made up of carbon atoms only, in other cases of carbon atoms interspersed with oxygen, nitrogen, or sulfur atoms; other groups may be attached to these chains dependent upon the monomeric materials from which the polymer was made. Since there are hundreds of C-C bonds and C-H bonds in any one molecule of a high polymer and different products are produced when each is cleaved, it is apparent that a very complex set of products is produced when an actual polymer is irradiated.

Effect on Polymers

As mentioned above, the first reaction that occurs on irradiation of organic substances is that of making small pieces out of a large one. The free radicals produced as intermediates exist for very small periods of time, of the order of thousandths of a second. As illustrated by arrows 3 and 5 in the figure, larger molecules can be produced by combination of the radicals when the radicals can come together during this short period of time. When two adjacent chains join together by this process in one or more places, the operation is known as cross-bridging and leads to a larger, less flexible molecular structure. During this short period of time, other radicals add a hydrogen or lose a hydrogen, as illustrated by arrows 2 and 4, to produce molecules no larger than and possibly smaller than the original molecule. Both of these effects can be very undesirable and some plastics, for example acrylates, have been observed to disintegrate and almost pulverize after exposure to gamma irradiation.

The physical properties of a given polymer are dependent upon the molecular weight and particularly upon the extent of cross-bridging (arrow 3). When there is little or no cross-bridging of adjacent long

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Joseph J. Martin received his D. Sc. in Chemical Engineering at Carnegie Institute of Technology in 1948. He had previously held the position of chemical engineer at Eastman Kodak Co., and taught at the University of Rochester, Carnegie Institute of Technology, and the University of Michigan. Dr. Martin became an Associate Professor of Chemical Engineering at Michigan in 1950.

by Gamma Rays

How better plastics may be created by gamma irradiation of certain monomers, and an analysis of prospective economics

by LEIGH C. ANDERSON and JOSEPH J. MARTIN

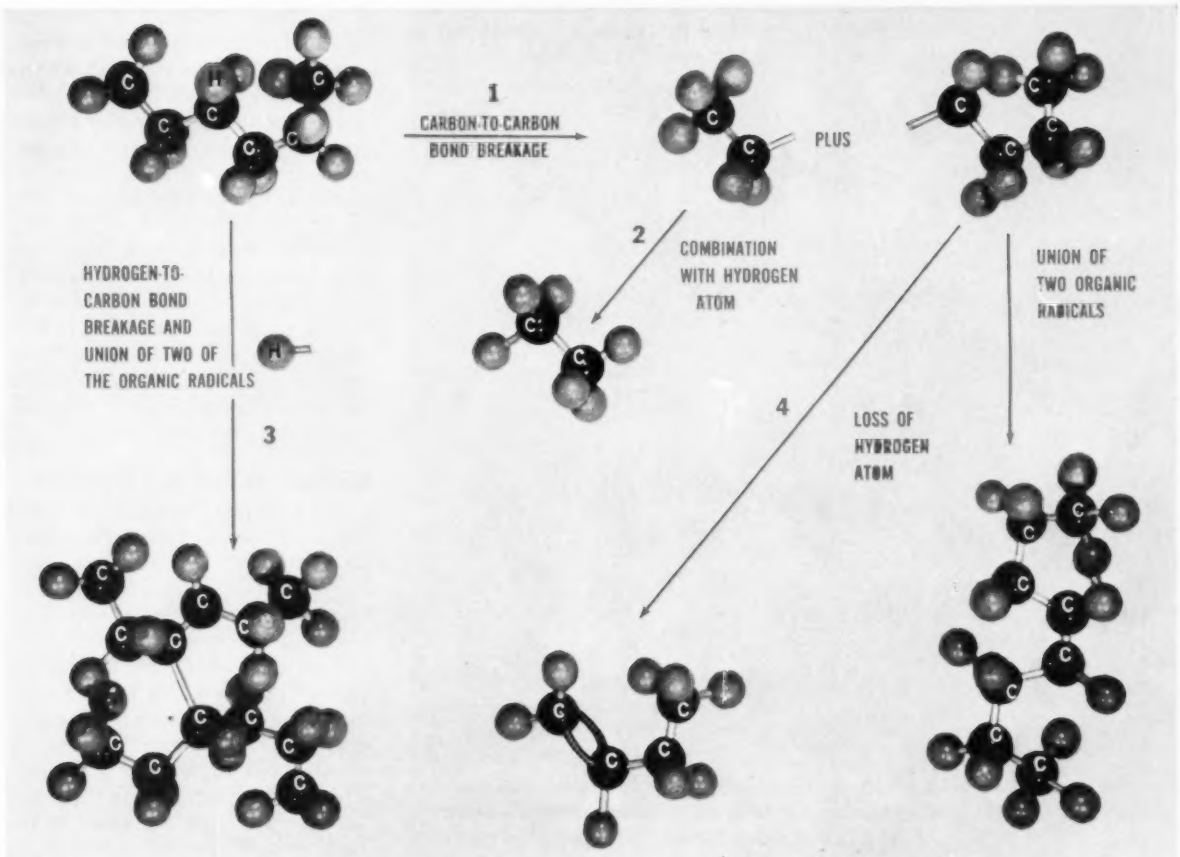

Fig. 1—What is assumed to happen when a gamma ray breaks one carbon-to-carbon or one carbon-to-hydrogen bond of hexane, a six-carbon compound. The illustration indicates that one two-carbon radical and one four-carbon radical are formed

chains in a polymer, the polymer becomes plastic at elevated temperatures, like unvulcanized rubber, and can be molded. As the amount of cross-bridging increases, the polymer becomes more rigid and finally reaches a state where the hot polymer is no longer plastic, as illustrated by vulcanized rubber.

Irradiation of some polymers can be shown to produce such cross-bridging with the change in properties indicated above and it has been found that after a certain amount of irradiation, the polymer can no longer be molded. At the same time that the material is losing its thermoplastic properties, it is also becoming more brittle, a state which is not always desirable. If the formation of smaller molecules, which is occurring continuously during irradiation, is allowed to proceed too far, the polymer may lose many of its good characteristics and even show various signs of serious disintegration.

The above discussion stresses the disadvantages which may accompany *too much* irradiation by gamma rays, but they also indicate some of the advantages which may be produced by *proper amounts* of irradiation. The increased resistance to thermal softening, which accompanies cross-bridging, may be a very valuable change to induce in a polymer. Since the effect sought would make it difficult to mold the cross-bridged polymer, it would be more satisfactory to produce the cross-bridging *after* the polymer has been made into its final form. The high penetrating power of gamma rays, as well as the fact that they produce the effect at low temperatures, would mean that upon irradiation of the polymerized object, cross-bridging

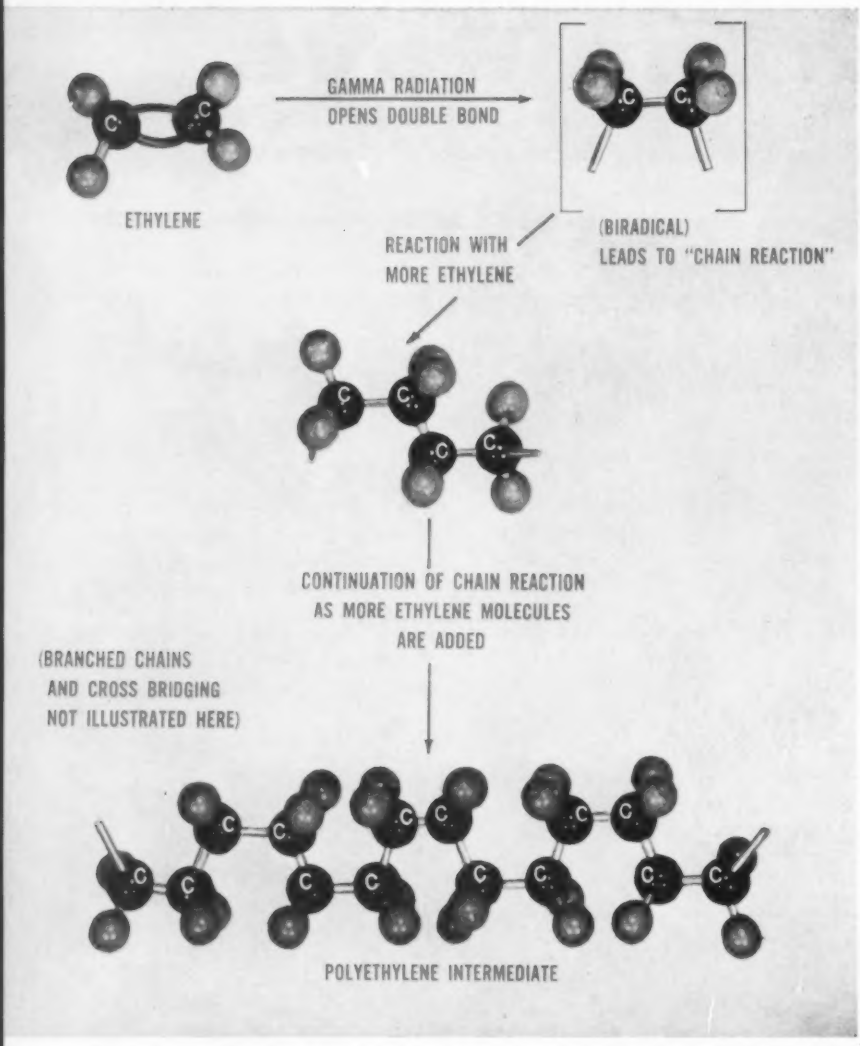

Fig. 2—Process in which gamma radiation breaks double bond of ethylene molecule, starting a "chain reaction" which creates new side bonds and accomplishes polymerization

might be expected to occur all through the material without much change in surface appearance or distortion of the object.

Effect on Monomers

There is a very great difference in the rates at which different monomers are polymerized by gamma irradiation. Vinyl acetate, for example, polymerizes much faster than styrene under the influence of gamma irradiation. As polymerization proceeds, the polymerized product is still subject to the effect of the gamma rays and secondary changes similar to those discussed previously will occur.

The original polymer produced by gamma irradiation is sometimes different from that obtained by more standard procedures such as thermal activation or peroxide initiation. Polyethylene, as produced commercially, consists of long carbon chains with numerous shorter chains attached to the long one. Some samples of gamma-induced polyethylene, however, show considerably less branching and, since no catalyst residue is included in the product, the polymer contains a lower oxygen concentration and does not contain other impurities introduced by the use of catalysts. These are factors which may have a marked effect upon some of the properties of the polymer. Because of a certain amount of cross-bridging in the product, solid polyethylene produced from ethylene by gamma irradiation is stiffer and has a higher tensile strength than commercial polyethylenes (Fig. 2). As indicated earlier, however, these effects are to be expected from gamma irradiation of any organic polymer.

Very different types of products are obtained when ethylene is polymerized at different temperatures under the influence of gamma irradiation. Usual non-nuclear industrial procedures for polymerizing ethylene call for temperatures of the order of 200° C. (392° F.) and pressures of many thousands of pounds. At this temperature, and at pressures of about 1200 lb., gamma irradiation of ethylene produced only liquid polyethylenes.

The toughest polyethylenes that have been produced by gamma irradiation were made at approximately room temperature and pressures near a thousand pounds. These are the polymers which probably have the greatest amount of cross-linking, as mentioned earlier.

Economics of Radiation Processing

Granted that radiation-catalyzed polymers, such as polyethylene, may have different and in some cases better properties than those catalyzed by heat or conventional catalysts, still the decision to use radiation for this purpose will in the end depend upon relative costs. In the case of a polymer which may be produced by a radiation reaction, or equally well by heat, or a catalyst, a direct comparison may be made between the two processes if the costs of radiation are known. If the polymer produced by radiation has significantly different properties from that produced by conventional means, then one is forced to compare the radiation polymer with other entirely different polymers that may have comparable properties and which are produced by conventional means. If there are no other comparable polymers that can do the same job as the radiation polymer, it is possible the radiation polymer will find use even though its cost of production may be very high.

In estimating the costs of producing polymers by radiation, the same principles of capital investment, interest, raw materials, labor, maintenance, and operation charges apply, as must be considered for usual

manufacturing operations. The bulk of these are well known and can be determined from published information. However, because radiation, other than ultra-violet, is such a new processing tool which is really only in the development stage, the estimates of its cost may vary widely. The source of the radiation will also determine its cost, and there are several possible sources. In this discussion consideration will be given only to sources of gamma radiation that result from the operation of nuclear reactors.

Fission Products

Nuclear reactors produce large amounts of radiation which must be confined by their shielding walls. If chemical reactions are to utilize this radiation, they must be conducted within the reactor itself. If this is not feasible, as usually would be the case, then the chemical reactions must utilize the radiation in a secondary manner from the products which are removed from the nuclear reactor. This may be done in either of two ways: 1) The fission products which result from the "burning" of the nuclear fuel may be brought out and used in a separate chemical plant near the nuclear reactor, or they may be packaged and shipped to chemical plants away from the reactor site. 2) Cooling fluids, such as water or similar materials, may be circulated through the nuclear reactor where, in the presence of the neutron flux, they become radioactive. These materials would then be conducted through a nearby chemical reactor to absorb their radiation before being returned to the nuclear reactor or discharged to the surroundings.

In view of the fact that large amounts of the fission products have already been accumulated at various sites of reactors operated by the Atomic Energy Commission, it seems reasonable that such fission products will be among the first sources of radiation to be employed by the chemical industry. In fact, it was with the hope of utilizing these fission products that the Atomic Energy Commission inaugurated an extensive research program to discover chemical reactions that would be promoted by gamma radiation. Since packaging and shipping procedures for fission products had not been developed sufficiently, the laboratories which participated in this program have been using cobalt-60, an isotope which can be readily produced in a nuclear reactor. It is expected that many cobalt-60 sources may be replaced with fission products as soon as the latter are available.

Cost Per Curie

The price which the Atomic Energy Commission has placed on cobalt-60 is about $5.00 per curie. The curie rating of a piece of cobalt-60 is always decreasing, for a radiation source is always "growing darker" or "decaying." The rate at which a source of radiation is diminishing is dependent upon its half-life. The half-life of cobalt-60 is about 5.3 years, which simply means that a source of say 5000 curies will be only 2500 curies at the end of 5.3 years. Thus, of two sources with the same intensity, the one with the longer half-life is the more valuable.

The fission products which are produced in a nuclear reactor vary in half-life from a few minutes to many years. If one is to make use of the radiation from the short half-life material, he must use it as soon as possible after it comes out of the reactor. This probably means that such usage will be confined to the immediate neighborhood of the reactor, and also that a rather low price per curie will be placed on this product. The long-life material, on the other hand, may be packaged and shipped to distant points for use as polymer promoters. The latter would certainly be worth a lot more than the short-life material, and a value of $5.00 per curie might be very realistic. Since the government is currently storing fission product wastes where they are not being used at all, it seems possible that the price of radiation used in the neighborhood of the reactor might be as little as $0.0005 per curie. The difficulty of making an accurate cost estimate for radiation for chemical processing is obvious, therefore, until pricing policies are firmly established. However, just to get some idea of cost of radiation processing, we shall assume that fission products of at least two-year half-life are available at $0.10 per curie.

Bench-scale laboratory studies at the University of Michigan have shown that 10 curies of cobalt-60 can convert approximately 0.01 lb. ethyl-

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Credits

THE editors acknowledge with thanks the cooperation of the following companies and individuals in the preparation of the various articles in this issue on nuclear energy and its uses:

American Agile Corp.: F. J. Bockhoff; C. F. Freedman

American Hard Rubber Co.: G. H. Reed

American Machine & Foundry Co.: A. W. Peterson

Anchor Plastics Co.: Robert Marx

Atomic Industrial Forum, Inc.: Edward Wiggin

Bakelite Co., a Div. of Union Carbide & Carbon: L. K. Merrill; Don Masson

Diamond Alkali Co.: Dr. A. W. Meyer

The Dow Chemical Co.: Harold A. Cook

General Electric Co., Chemical and Metallurgical Div.: P. A. Goodwin; Paul Gavaghan

General Electric Co., X-Ray Dept.: Joseph Ranftl; R. A. Baver; David Goodman

General Tire & Rubber Co.: Edward B. Butler

Goodyear Tire & Rubber Co.: J. F. McCormick

High Voltage Engineering Corp.: F. L. Foster

Kaiser Aluminum & Chemical Corp.: C. M. Fredrickson

Knolls Atomic Power Lab.: Dr. Samuel S. Jones

Koppers Co., Inc.: George Van Gundy

Molesworth Associates: Gordon Molesworth; Dixon Johnson

Radiation Applications, Inc.: Dr. Ernest J. Henley; Dr. Bernard Manowitz

Resistoflex Corp.: B. M. Walker

Rohm & Haas Co.: Colin C. Campbell

Standard Oil Development Co.: W. E. McTurk

Tracerlab, Inc.: Philip Brady; Dr. F. H. Low; Dr. Gilbert Corwin

Tupper Corp.: Earl S. Tupper

United States Atomic Energy Commission: Dr. P. C. Aebersold, director, Isotopes Div., Oak Ridge, Tenn.; Charles R. Horner, Div. of Reactor Development; Edward Brunenkant, chief, Industrial Information Branch; Oscar M. Bizzell, chief, Technical Developments Branch, Isotopes Div.

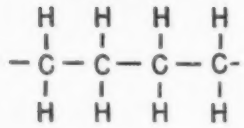
United States Rubber Co.: A. L. McNomee

University of Michigan: Drs. L. C. Anderson, J. J. Martin

How Cross-Linking

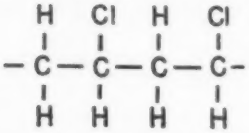
A

Polyethylene



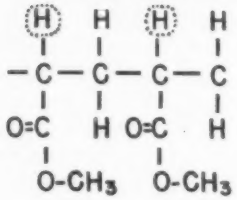
B

Polyvinyl chloride



C

Polymethyl acrylate



(H) = α HYDROGEN

D

Polymethyl methacrylate

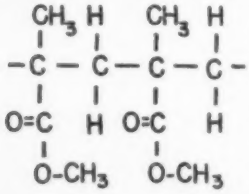


Fig. 1—Molecular structure of four polymers. In addition to the primary bonds between carbon atoms, there exists a secondary attraction between adjacent groups in the polymer chain

MELTING points, strength, permeability, elasticity, and related physical properties of plastics can be attributed directly to: 1) the number of atoms per molecule, 2) the electronic forces between the constituent atoms, and 3) the arrangement of the molecules in space.

A polyethylene molecule, for instance, is made up of a chain of carbon atoms, each of which is chemically linked to two carbon and two hydrogen atoms (Fig. 1, a). What determines the properties of a piece of polyethylene is not the strength of the primary bonds between the carbon atoms, but the secondary attractions between each one of the ethylenic groups in the chain and its image in the molecules lying adjacent and parallel to itself.

Electronic Attraction

The more ethylenic groups there are, per molecule, to exert their weak attraction on an adjacent molecule, the greater the strength of the "bond" between the two molecules. This increasing internal attraction between molecules, with increasing molecule weight, explains why butane (Molecule Weight [MW] 58) is a liquid, paraffin (MW 500) is a liquid wax, and polyethylene (MW 10,000) is a solid, despite the fact that the chemical composition of these three substances is exactly alike.

The effect of increasing molecular weight on the physical properties of polymers is presented in Table I. Substitution of a chlorine atom for a hydrogen atom in polyethylene (Fig. 1, b) alters the electronic forces which account for the intermolecular attraction. In this instance, since chlorine has a "larger" electronic field of force, there is an increase in the properties usually associated with strength when polyvinyl chloride is compared with polyethylene. The effect of increasing the attraction between polymer chains by substituting groups into the chains which have a strong mutual chemical affinity is shown in the appropriate column of Table I.

Arrangement of Molecules

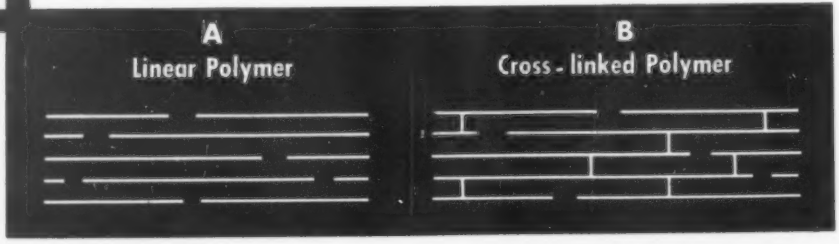
The third factor, molecular arrangement or "fit," affects strength in a more subtle and indirect way. For maximum attraction the atoms must be in a physical arrangement from which they can exert their optimum mutual forces. Since each molecule has a unique structural arrangement, the adjacent chains must line up so that their patterns are complementary. If this cannot be, the strength, elasticity, etc., will be affected (see Table I).

Cross-linking is a geometric phenomenon that is easy to visualize. If one can hold together the long parallel chains with "primary" chemical bonds instead of the loose "secondary" forces which normally bind them together, then impressive changes in physical properties can be achieved. This is seen in Table II.

It should be noted that cross-linking is directly related to molecular weight, since every time two bundles of molecules are linked chemically, the molecular weight is doubled. When each chain has been cross-linked a number of times, the result is called a "gel structure," a "network," "infinite molecular weight,"

* Department of Chemical Engineering, Columbia University; Associate, Radiation Applications, Inc.

Fig. 2—Schematic diagram of linear (A) and cross-linked (B) geometric alignments of plastics. Cross-linking polyethylene changes it from a thermoplastic to a thermoset



Works

Physical properties of plastics depend upon molecular types and constructions; irradiation can produce large, linked molecules and, hence, property changes

by E. J. HENLEY*

"space polymer," or "three-dimensional polymer." Figure 2 demonstrates the linear and cross-linked geometrical alignments of plastics.

Basic Laws

An understanding of the basic laws of radiation chemistry, coupled with a recognition of the factors which influence the physical properties of plastics, will permit some predictions and generalizations on the effects of radiation on plastics.

In dealing with atomic radiation, the most important factor to consider is the very high energies involved. Each X-ray or every electron of sufficient energy to give good penetration contains about 50,000 times the energy of a chemical bond. When these high energy radiations collide with a molecule they unbalance the outer electrical structure, literally tearing the bonds apart, and knocking electrons out of their orbits. This is a process known as ionization. The particles do not, however, enter the nucleus or cause fission, so no radioactivity is induced during this type of treatment.

The elementary processes in the interaction of high-energy radiation with matter are, therefore, quite clear. There is an initial transfer of energy from the radiation beam to an atom; this results in the ejection of an electron. This ejected electron for the case of 1 m.e.v. (million electron volts) radiation, for instance, can produce 15,000 further ionizations. For this reason, X-rays and radiations of particles produce reasonably similar changes for the same energy inputs. These energy inputs, incidentally, are very small. A dose of a million roentgens is equivalent to approximately two calories, and will disrupt less than one out of every billion molecules of air.

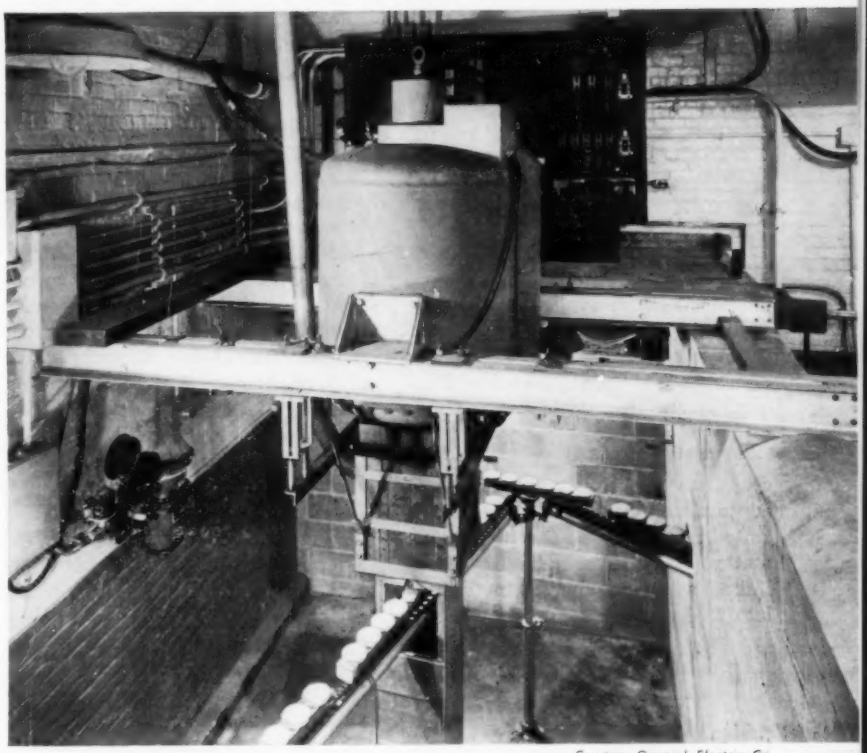
Molecular Disruption

From the foregoing discussion, the first event that one may predict would occur in the wake of a beam of ionizing radiation which is passing through a plastic, is a complete and random disruption of any and all molecular species. This is exactly what happens.

In addition to the random changes which occur, a certain amount of degradation and depolymerization always accompanies a beam of ionizing radiation. As a point of actual fact, in some plastics, this is the only effect observed.

Since some bonds in the plastic molecules are weaker than others, perhaps part of the radiant energy is selectively "stolen" and transferred to particularly vulnerable points in the polymer chains. If this happens, one could expect to observe the occurrence of non-random or ordered events. This may take form of: 1) a separation of one particular molecule or group of molecules out of the chain; 2) further polymerization, in case unsaturation was present or induced; or 3) selective decomposition of a specific side chain. Again, all of these expectations are realized.

Certain decomposition products are found in a much higher concentration than one would predict on the basis of random radiation effects. The pulling out of these species, particularly hydrogen, leads to unsaturation, which then, in some instances, leads to further polymerization or cross-linking. One method of predicting whether only degradation or degradation plus cross-linking would occur in irradiated polymers, has recently been proposed by Miller et al.[1] They assume that if a



Courtesy General Electric Co.

Production-line set-up for irradiating plastics products to produce cross-linked polymers. Conveyor belt moves products under an electron generator where they are irradiated

[1] Miller, A. A., Lawton, E. J., Balwit, J. S., J. Polym. Sci., *14*, 503, (Dec. 1954)

University Research Reactors

The following university reactors are, or upon completion will be, available to industrial users for research purposes under certain conditions:

In operation—North Carolina State College, Raleigh, N. C.

Under construction—University of Michigan, Ann Arbor, Mich.

To be constructed—Pennsylvania State University, State College, Pa.; Batelle Memorial Institute, Columbus, Ohio; Armour Research Institute, Chicago, Ill.; and Massachusetts Institute of Technology, Cambridge, Mass.

polymer has an available hydrogen (α hydrogen) on a carbon adjacent to the characteristic side group, this hydrogen will be abstracted; consequently the chain will become unsaturated and cross-linking will occur. In the absence of one or more α hydrogens, the polymer chain will rupture and degrade. This is illustrated nicely by the fact that polymethyl acrylate is radiation cross-linked while polymethyl methacrylate is degraded. A diagram of the molecular structure of these two plastics materials is shown in Fig. 1, c and d.

A more detailed examination of the physical and chemical changes in plastics brought about by radiation, is presented in Table II. Individual credits for the data are not given. The data were abstracted from references 1), 2), and 3) at the end of this article. Polymers such as polyisobutylene, Kel-F, dextran, methyl methacrylate, etc., which have no α hydrogen, or for other reasons are known only to degrade on radiation, are not listed.

Polyethylene — About two million roentgen are sufficient to transform polyethylene from a low melting soluble polymer to a material which no longer melts. About 20 million roentgen link the chains together into one large molecule or gel which is insoluble in the usual solvents.

The doses given in Table II are always a function of the initial molecular weights, i.e. higher doses are required to give effective cross links as the initial molecular weights decrease. All doses given in Table II are approximately correct for commercial samples.

Radiation doses of up to 10^8 roentgen have little effect on tensile strength or elastic properties at room temperature. Gas permeability is also unaffected. The most striking and useful development is the increased strength above 100° C. which is now sufficient to allow containers, etc., to support their own weight. Paraffin wax may be considered to be a low molecular weight polyethylene, so that higher doses of radiation are required to achieve a gel structure.

Rubbers — Rubber is a naturally occurring polymer of similar composition as polyethylene. Since the rubber already contains some unsaturation, it may be cross-linked with somewhat lower doses of radiation than may polyethylene. The process and the effects are akin to vulcanization.

Polystyrene — Again polyethylene type of effects are observed. No appreciable changes of physical properties occur, but marked increases in heat stability and insolubility follow radiation treatment. Polystyrene requires roughly 50 times the radiation dose to effect changes comparable in magnitude to those induced in polyethylene.

Others — Very little detailed experimental data appear in available literature regarding polyvinyl alcohol, silicones, chlorinated polyethylene, and nylon. It is, however, well known that these materials have been successfully cross-linked.

As a modifier of plastic products, radiation is not revolutionary; rather it represents a small technological advance. Polyethylene at this time is the only material which shows sufficient improvement after relatively low dosages of irradiation to warrant attention.

Present costs of radiation processing are high. G.E.'s Irrathene radiation cross-linked polyethylene insulating tape, sells for about 10 times the price of the comparable non-irradiated Visking sheet. Unless vast improvements in the cost and availability of radiation sources are realized, for the next few years radiation processing will, probably, double the price of bulk polyethylene sheet (60¢/lb.). This figure is based on the assumption that 20 million roentgen are necessary to achieve characteristics desired.

Radiation processing of foods and pharmaceuticals may yield inferential benefits to the plastics industry. The glass bottle and tin can used in conventional steam processing techniques diverts an inordinate amount of radiation from the incident beam. Plastics have more favorable characteristics in this respect and offer an additional bonus: they do not discolor on irradiation.

Many improvements on the physical and chemical properties of plastics must be realized before plastic canning of foods or drugs may become commonplace, but it is interesting to note that some of the improvements can occur on the job while the plastic container is radiation sterilized.

Table I—Criteria Affecting Physical Properties of Polymers

	Increasing Molecular weight	*Increasing attraction between molecules*	*Geometric 'Fit' (Crystallinity)*	*Cross-linking*
MP	+	+	s+	+
Strength	+	+	+	+
Elasticity	s+	s—	—	?
Volume resistivity	0	0	0	0
Permeability	0	—	—	0
Solubility	—	s—	0	—

+ = increase 0 = no effect
— = decrease s+ or s— = small increase or decrease
? = small effect depending on polymer

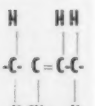
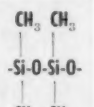
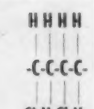
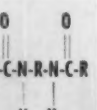
References

1) Lawton, E. J., Balwit, J. S., Bueche, A. M., I. & E. C., *46*, 1703 (1954)

2) Bopp, C. D., Sisman, O., ORNL, 1373 (Feb. 1954)

3) Charlesby, A., Nucleonics, *12*. 18 (1954)

Table II—Effects of Various Doses of Radiation on Properties of Cross-linked Chemicals

Polymer	Structure	Total dose	Type of radiation	Gaseous products	Appearance	Melting point	Ultimate elongation	Breaking strength		Toluene solubility	Volume resistivity
		$\times 10^{-6}$ roentgen				° C.	%	p.s.i.	p.s.i.		Ohm-cm.
Polyethylene		0	neutron,	C	white	110	550	3000-20° C.	0-150° C.	Yes	
		3.5	gamma, beta		white-yellow	none	630	3100-20° C.		Yes	
		5			yellowish	"	700	3200-20° C.		No	
		15			yellow-white	"	700	3250-20° C.	400-100° C.	No	
		100			amber	"	150	3100-20° C.		No	
		>100			dark amber	"	< 100	< 3100-20° C.		No	
Parrafin wax		0	neutron,	C	wax	< 100				Yes	
		900	gamma		rubber	none				No	
Rubbers, including poly-isoprene, Neoprene, etc.		0	neutron,	B-C			460	2900		Yes	$> 10^{14}$
		0.5	gamma, beta							No	
		5								No	
		50								No	
		>50					160	2600		No	10^{12}
Styrene		0	neutron,	A		250	1.4	6000		Yes	6×10^{14}
		300	gamma, beta			none	1.4	6000		No	6×10^{14}
Polyvinyl alcohol		0	neutron,	C						Yes	
		10	gamma							No	
Silicones		3	neutron,	B-C	grease						
		>100	gamma		solid						
Polyvinyl-chloride		0	neutron,				310	2800		Yes	10^{13}
		100	gamma				250	3000		No	10^{7}
Nylon		0	neutron,	C			40 30	8900 8800			
		50	gamma								

*A = <0.01 molecules/100 e.v., B = 0.01 to 0.5 molecules/100 e.v., C = 0.5 to 3 molecules/100 e.v.

Applications of Irradiated

Two Types of Films

by P. A. GOODWIN*

MOST of the development work on the irradiation of plastics in the Chemical and Metallurgical Div. of General Electric Co. is centered on Irrathene irradiated polyethylene. Irrathene irradiated polyethylene, the first commercial plastic product of radiation chemistry, is being produced in large pilot-plant quantities for experimental purposes. Still limited to use in tapes and films, the material is produced in two grades, Irrathene 101 and 201.

G-E Irrathene 101 irradiated polyethylene is, like the conventional type, tough, moisture resistant, and chemically inert. But it does not melt at temperatures as high as 350° F. and has outstanding resistance to stress-cracking in a broad range of chemicals. The material is lightly cross-linked, just enough to make it non-melting without change in flexibility or toughness (see Table I).

Irrathene 201 irradiated polyethylene was developed especially for electrical insulation and contains an oxidation inhibitor which will permit its continuous use at 125° C. (257° F.), or even higher in special applications (see Table II).

Development work on other forms of irradiated polyethylene is occupying most of the attention of the product and process development groups, and it is expected that several new products will be added to the line.

The radiation source used for both development and production is the G-E, 1-m.e.v., resonant-transformer electron generator.

Research and development work on other irradiated materials is still being intensively pursued at the G-E Research Laboratory in Schenectady.

Irrathene irradiated polyethylene insulating tapes and films are beginning to find acceptance in the electrical industry, especially for cable and motor insulation. Development programs on the uses of Irrathene insulation are in progress now in a large number of electrical manufacturing companies.

* Market Evaluation Unit, Chemical Development Dept., General Electric Co.

Table I—Physical Properties of Irrathene 101 Irradiated Polyethylene

Property	Value
Tensile strength (p.s.i.)	1800 to 2200
Modulus of elasticity	18,000 to 20,000
Ultimate elongation	500 to 600%
Hardness (Rockwell)	R11
Specific gravity	0.92
Water absorption	Negligible
Flammability	Slow burning
Chemical resistance	Excellent resistance to acids or alkalies
Solvent resistance	Good below 60° C. Swollen by hydrocarbons and chlorinated compounds above 60 to 100° C.
Resistance to sunlight	Must be protected from sunlight

Table II—Electrical Properties of Irrathene 201 Irradiated Polyethylene

Property	Value
Dielectric Strength (0.005 in. film)	
S/T 25° C.	2500 volts/mil
50°	2300 volts/mil
100°	1800 volts/mil
150°	1400 volts/mil
200°	1100 volts/mil
200°	1100 volts/mil
S/S 25°	1800 volts/mil
50°	1800 volts/mil
Volume resistivity	$> 10^{16}$ ohms-cm.
Power factor	
60 cycles	< 0.0005
1 mc.	< 0.0005
10,000 mc.	< 0.0005
Dielectric constant	
60 cycles	2.3
1 mc.	2.3
10,000 mc.	2.3

Courtesy General Electric Co.

Although commercial use of Irrathane irradiated polyethylene is still limited to tapes and films, other fields are being explored. For example, test results on containers indicate improved heat resistance of the irradiated type as compared with the non-irradiated variety

Among all plastics processors, two companies have produced marketable materials by the irradiation of polymerized ethylene. Both companies use electron bombardment and the results quite clearly point up future probabilities

Polyethylene

Formable Sheet

by F. J. BOCKHOFF* and J. A. NEUMANN*

SHEET MATERIAL which can be formed in thick sections and to extremely deep draws can be produced by irradiation of conventional polyethylene sheet. Details of such forming will be given later in this article, after a consideration of the irradiation process and its results.

Irradiation by high-energy particles of finished polyethylene in sheet, molded, or fabricated form produces striking changes in the properties of the material (1, 2, 3, 4[1]). Such irradiation can be carried out with beta, gamma, or cathode rays from any source, the choice of the source being primarily economic.

Irradiation of polyethylene is remarkably similar to vulcanization of rubber. Polyethylene is changed from an easily fusible thermoplastic to a thermosetting material which retains form stability at temperatures as high as 400° F. Certain mechanical properties are improved and these improvements are retained at elevated temperatures. Solvent and chemical resistance are increased and the annoying phenomenon of stress cracking is completely eliminated. Yet, within proper dose ranges, irradiated polyethylene retains all of the traditionally desirable properties of conventional polyethylene: toughness, flexibility, impact resistance, and complete inertness in most chemical environments.

Commercial Irradiation Sources

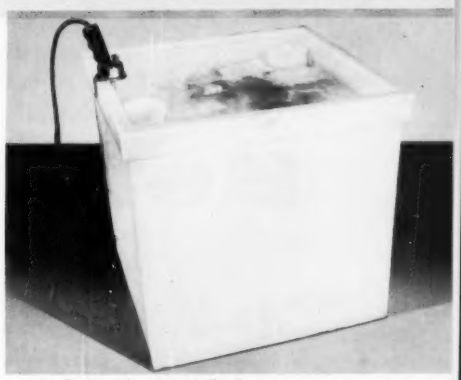
Although any type of high energy irradiation produces the same end result, electron bombardment presently appears to be the most feasible type of commercial treatment, considering both control and economic factors.

The voltage of the electron beam is quite important in assuring the proper depth of penetration. For a one-million-volt beam, the depth of penetration from one side only is about ½ centimeter. Irradiating an object from both sides with a one-million-volt beam will allow a total thickness of about 1 cm. to be treated. Higher voltages increase the depth of penetration in a linear manner.

From an economic standpoint, future electron generators must be built to higher power-output specifications in order to bring down the cost per kilowatt-hour of irradiation. At present, the greatest cost of operation is amortization of the equipment, which is high when based on low-power-output units.

The most promising development appears to lie in the direction of linear accelerators which can be built to very high voltages with rela-

(*To page* 212)



Courtesy American Agile Corp.
Tank of one-piece molded construction is made of irradiated polyethylene

Courtesy American Agile Corp.
Deep-drawn fuel reservoir was vacuum formed of irradiated polyethylene sheet

Table I—Typical Properties of Agilene-HT at Room Temperature

Property	*A.S.T.M. Designation*	*Value*
Tensile strength	D 412-51 T	1800 to 2100 p.s.i.
Elongation	D 412-51 T	600%
Stiffness	D 747-50	45,000 p.s.i.
Specific gravity	D 792-50	0.92
Shore hardness "D"	D 676-49 T	48
Impact strength, Izod	D 256-47 T	Did not break
Water absorption		Negligible
Dielectric constant (60 cycles to 100 mc.)	D 150-47 T	2.3
Power factor (60 cycles to 100 mc.)	D 150-47 T	< 0.0005
Chemical resistance		Excellent
Flammability		Slow burning

* American Agile Corp.
[1] See references at end of article, p. 214.

Thickness Control by Beta Gages

Two types of instruments using beta particles to measure sheet thickness during production, and at any speed, can be used in fully automatic control systems

by GILBERT CORWIN*

AN IMPORTANT industrial development stemming from America's vast atomic energy program is the beta gage—a unique electronic device which makes it possible for processors of sheet plastics to cut raw material costs, improve quality by tightening thickness specifications, and greatly reduce sub-standard production.

Now being used by increasing numbers of plastics manufacturers, beta gages continuously measure the weight per unit area of sheet products without contacting the material being gaged. And they do this regardless of machine speed and even when the material is in a soft, semi-formed state and not susceptible to being gaged by any other non-destructive means. In addition, if the density of the product remains reasonably constant, as it does in most plastics sheet products, the gage can be calibrated directly in thickness.

*Chief Applications Engineer, Tracerlab, Inc., Boston, Mass.

Basic Types

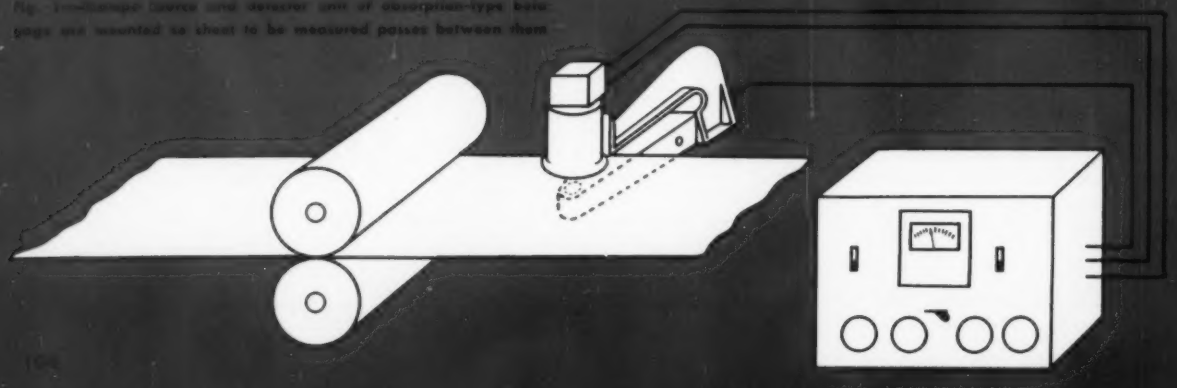
Since beta gages were first introduced in 1949, they have evolved into dependable, factory-proven equipment designed and built for continuous operation under adverse conditions of dust and humidity, and in explosive atmospheres.

There are two basic beta gage types: "absorption" and "backscatter." Absorption type gages (Fig. 1) have a source of radioactivity and a separate detector, mounted so that the sheet passes between these two elements. The backscatter type gage (Fig. 2) is so constructed that source and detector are in one unit, thus making it ideal for use where mounting space is limited or for coating applications where the thickness of a coating as it passes over a calender is to be determined.

The principles—both nuclear and electronic—upon which beta gages operate are simple. In the absorption gage a small, shielded radioactive source—which may be strontium-90, ruthenium-106, cesium-137, or thallium-204—is contained within the lower portion of a C-frame, directly under the cylindrical ionization chamber, or detector unit. The radioactive source gives off either high, low, or medium energy beta particles depending on the radioisotope being used, and these particles—which are actually electrons with high kinetic energy—pass through the sheet and into the detecting chamber.

Because the source capsule containing the isotope is triply sealed, no activity can escape to contaminate the product and the source chamber is shielded to minimize radiation in any direction but toward the detector. There are essentially no personnel safety problems.

The beta particles penetrate the moving sheet and variations in the weight per unit area (thickness) of the material increase or decrease the number of electrons which get through the material and enter the detecting head. Every change brings about a corresponding change in the electrical current flowing to the meter of the recorder and sheet var-

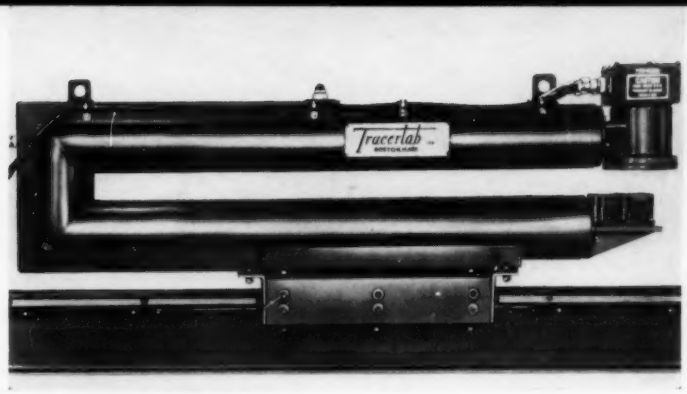


iations are thus easily measured. Since the number of beta particles is small, the effect is small and the ionization current developed by the source of the beta gage is about 3×10^{-9} ampere or one one thousandth of one millionth of an ampere. However, this current can be measured.

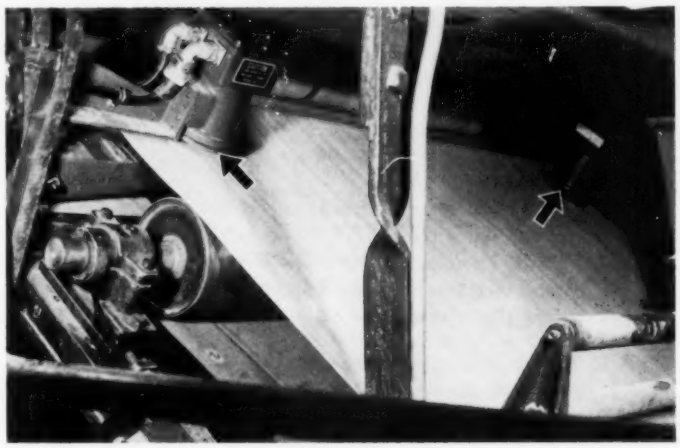
Backscatter beta gages utilize the same principles with the major difference being that the beta particles must penetrate the sheet, strike a backing plate (or roll), return (backscatter) through the product being measured, and enter the ionization chamber. The process is quite similar to that of shining a flashlight into a mirror and observing the reflection.

Another factor to be considered where backscatter gages are concerned is the atomic number of both the product to be gaged and the backing over which the product passes at the point of gaging. The ability to backscatter beta particles is related to the material's atomic number. If a coating or layer of a different material is placed over the backing, the current flowing from the ionization chamber to the recording meter *decreases* if material with a *lower* atomic number is used, and *increases* if a material having a *higher* atomic number is measured. The minimum thickness of the backing must be great enough so that variations in thickness do not influence the gage readings.

In actual use, the reflecting or backing surface is normally either a calender roll on the machine using the gage, or a plate over which the material travels. In most plastics applications the reflecting material is usually iron, steel, stainless steel, or chrome plated steel.



Absorption gage, shown mounted on machinery below (see arrows), has element giving off beta particles which, passing through sheet being measured, are absorbed in quantities depending on gage of sheet. Number of particles reaching detector indicates sheet thickness



In general, absorption gages have a product range for plastics of from 1 to 1100 lb./100 sq. yd.; backscatter gages have a maximum upper product limit of approximately one-half of that. In specific cases even these limits are not absolute.

All gages of whatever make or style, feed the electrical current gathered in the detecting element into a pre-amplifier which boosts the current to a measurable degree, and which in turn sends this current into an indicating meter. This meter is calibrated in accordance with the material being gaged and the sensitivity desired. It might be center zero with plus or minus deviations, or be directly calibrated in terms of thickness or weight per unit area.

Changes in sheet thickness can be noted by watching the needle or, as is true in most industrial installations, a recorder, either circular or strip chart type, can be teamed with the beta gage console to provide a

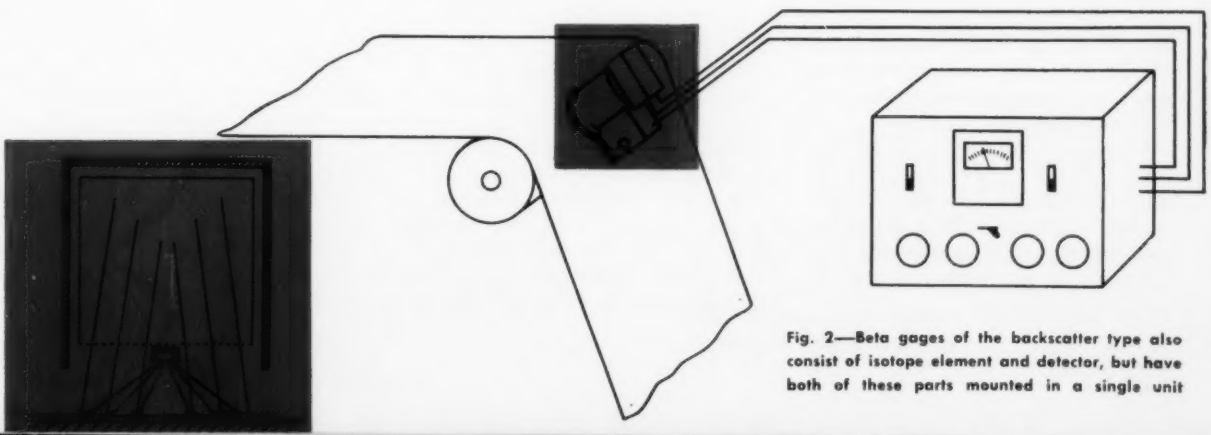
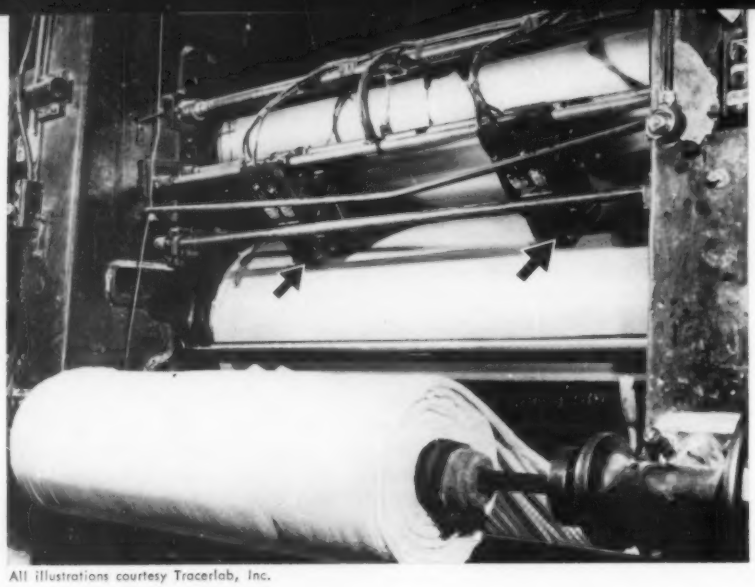


Fig. 2—Beta gages of the backscatter type also consist of isotope element and detector, but have both of these parts mounted in a single unit



When using backscatter gage (above and left, see arrows), beta particles pass through material being measured, strike backing plate or roll, and return through material to detector

All illustrations courtesy Tracerlab, Inc.

permanent production record of product variations.

The recorder can be fitted with visual or audible alarms and limit switches to signal when the gage readings indicate that the product has exceeded established tolerances. In many cases, of course, these limit switches are also used to actuate servo mechanisms and to transmit signals that automatically make the necessary corrections in the processing equipment to bring the product back into tolerance range.

Completely Automatic

A beta gage system can thus be completely automatic in all respects, or can be a more simple type in which the instrument meter (or remote meters which are available) are watched and manual corrections made. Usually this type of equipment can be converted to be automatic when desired.

Another variation that has developed in gages is equipment permitting the detector heads—either absorption or backscatter—to measure at any point across the sheet. There are also available power scanning mounts which automatically drive the detector and associated source (in the case of absorption gages) across the width of the sheet and retract the gage when the further side is reached.

Scanning gages are especially useful for sheet extrusion processes since measurements across the sheet provide rapid detection of erroneous die setting and temperatures, thus insuring the production of a much more uniform sheet.

Self-standardizing features are available by means of which the gage is automatically withdrawn from the product at regular intervals (15 min., perhaps) and automatically corrected for such things as the build-up of dirt on the detector and source windows, changes in the electronic components, and source decay. On the simpler manual standardizing gages, standardization which corrects for the same factors is usually performed about once in 8 hr. or sometimes more often.

Another style of gage now being used is the strip or profile scanner. This is essentially a laboratory tool and can be used to accumulate data on machine and product variations. Usually a strip is taken from across each roll of completed product, spooled, and then fed through the gage and the results presented on a strip-chart recorder. One paper manufacturer uses the gage not only to accumulate data about paper production, but also about the wearing of machine felts and wires.

Data Presentation

A unique method of presenting such profile data is to mount the chart on a sheet of cardboard, cut the card along the trace, and then place the cards horizontally one behind the other, thus obtaining a three dimensional picture of product variations. An important advantage of the strip scanner is that it eliminates the variations introduced in across-the-sheet scanning by the forward movement of the sheet.

Automatic gages often can incorporate push-button range selection so that operators can be unskilled and yet change from product to product by just pushing a button. On products where even occasional operator attention is not possible, the fully automatic gages are priceless.

Complete gage installations range in price from a few thousand dollars to as high as $25,000 or more for multiple gage, controlling set-ups.

Permacel Tape Corp., a user of beta gages, made the following comment two years ago, and it is now typical of the sentiments of a number of experienced gage users:

"Permacel Tape Corp. installed the first beta gage in December, 1952. All development runs have been completed and the beta gage has been in regular production for four months. Finished product quality has improved and raw material yields have increased from between 2 and 5 percent. The control of thickness by the beta gage has been amazing to our operators. When installed, our operators were completely distrustful of this 'new gadget'—the beta gage. Our experience has been such that our operators now have implicit faith in the beta gage and are pressing for additional installations. A second beta gage is currently being installed."

Beta gages have become an accepted and standard method of controlling sheet materials, of improving quality, and cutting raw material costs. The fact that many models are available, with a wide variety of performance characteristics and operational features, makes beta gages available to large and small manufacturers.

NEWS AND VIEWS OF PLASTICS PROGRESS

STOKES *plastics review*

VOL. 4
NO. 1
1955

PUBLISHED BY F. J. STOKES MACHINE COMPANY, PHILADELPHIA 20, PA.

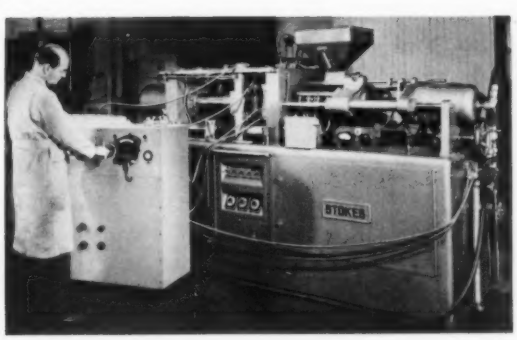
Another Custom Molder Praises Stokes Truly Automatic Injection Molding Machine

This 10-piece acrylic molding of lenses for a TV viewer is very difficult to mold due to the variation in thickness caused by the 32½ degree angle of the face. Pieces are not degated, per customer's specification.

More and more custom molders are turning to Stokes truly automatic injection molding for the low-cost production these versatile machines make possible. In this regard R. G. Cheney, President of Plastal Specialties Company, Seattle, Washington, writes: "We are very well pleased with the versatility of our Stokes 700 which is currently operating 24 hours a day, 7 days a week." A second machine ordered by Plastal will be in operation shortly.

The parts illustrated are typical of the variety and quality of pieces turned out by Plastal on the Stokes injection machine. The television viewer lens made for TV Colorscope required very careful control of cycle time, mold temperature and other variables in order to produce the optically flat surfaces required. Once this preliminary work was done, however, the Stokes 700 press produced the pieces automatically and economically, even though the long cycle time required would have been "wasteful of labor on any other type of machine," according to Mr. Cheney.

Nylon washers produced in a 12-cavity mold.



A Stokes Model 700 fully automatic injection molding machine at Plastal Specialties Co., Seattle, Wash. The versatility of the machine is particularly important to this custom molder.

A three-piece resistor housing of flame-resistant Tenite produced automatically in a 6-cavity mold. Total weight 3½ ounces.

Perhaps the most complicated single part—and one that shows the inventiveness of Plastal personnel—was a thermometer housing of high temperature styrene, produced for hot water bottle stoppers. This piece, with a long hollow tube up its center to receive the mercury column and a screw base, had to be unscrewed from the core. A gear and rack system was impracticable due to the distance involved. Plastal solved the problem by mounting a fluid motor on the mold and timing its driving mechanism through the electrical system of the press for fully automatic operation. Again, the Stokes 700 press produced these complex parts without attendance of any kind other than material supply and removal of finished pieces.

A thermometer housing for a hot water bottle stopper.

Finger splints of styrene are produced in a 3-cavity mold on the Stokes Model 700 injection molding press.

STOKES

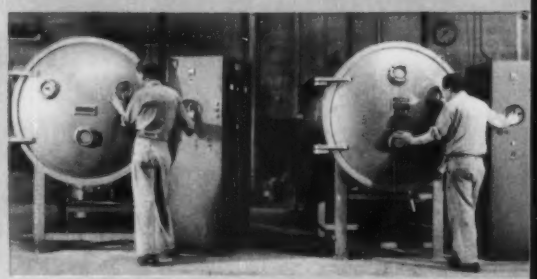
Molder and Metallizer Teamwork Needed to Achieve Minimum Cost

American Metalizing Corporation, started less than two years ago, has built its custom finishing business to such a large volume that a second Stokes 48-inch vacuum metallizing unit was purchased last fall to meet delivery schedules for a tremendous Christmas business in toys, novelty jewelry, and Christmas tree decorations. Most of the time, the plant runs three shifts a day, six days a week.

American Metalizing's president, Harry Saidel, has a philosophy which may be a clue to the success and growth of the firm. As Mr. Saidel puts it, "A plastics manufacturer with products that lend themselves to vacuum metallizing should certainly get together with his finisher at the earliest stage possible.

"The cost of the vacuum metallizing process alone is only a small part of the total finishing cost. By designing his molds so that the pieces delivered to the metallizer can be handled more efficiently, the plastics manufacturer can keep his bright-finishing cost down to an absolute minimum. Which means, of course, that his profit-margin will be higher."

American Metalizing Corp. metallizes a wide variety of plastic products in the two Stokes units. Novelty rings, earrings and other jewelry are typical of small items metallized in batches of thousands in 17 to 20-minute cycles. Another large business is done in "gold"-plating molded plastic shapes which assemble into elaborate lamp bases and simulate much larger solid metal pieces. Low-cost items to which metallizing gives a luxury look include lipstick cases, harp-shaped novelty flower pots, molded glass bottles for toiletries, bantam flashlights the size of a box of matches, Christmas tree decorations, toy cars and submarines, and toy musical instruments such as trumpets, clarinets, and baritone horns. At other times during the year American Metalizing keeps busy on such "industrial" items as flashlight reflectors and knobs for radio and TV sets. Mr. Saidel has also developed techniques for metallizing glass and metal products.



Two Stokes 48" vacuum metallizing units at American Metalizing Corporation, Bronx, N. Y. Typical parts given a bright, durable finish by this process are Christmas tree ornaments, jewelry, toys and toy musical instruments.

Pacific Coast Custom Molder Makes Stove Knobs on Stokes Model 800

A workman examines urea stove knobs made by Eldon Manufacturing Company on a Stokes Model 800 automatic compression molding press. The press operates 24 hours a day for this custom plastics molder.

The advantages of the new Stokes Model 800 fully automatic compression molding press are attracting increasingly favorable attention from plastics molders. This high-speed 15-ton molding press for thermosetting resins has a complete cycle time of 5 seconds, excluding cure. Since one man can attend up to a dozen or more of these presses, unit labor cost is low.

Eldon Manufacturing Company, a custom molder in Los Angeles, California, has operated its Model 800 fully automatic press 24 hours a day since they installed it nearly a year ago. The stove knobs shown in the photo are typical of the parts molded at low unit cost on the Stokes press. These urea parts are made in a two-cavity die.

Complete information on the Stokes Model 800 automatic compression molding press is contained in Bulletin 513. Also available is "Fully Automatic Molding", an interesting brochure on the theory and economies of automatic machines for plastics production. Ask for these on enclosed card.

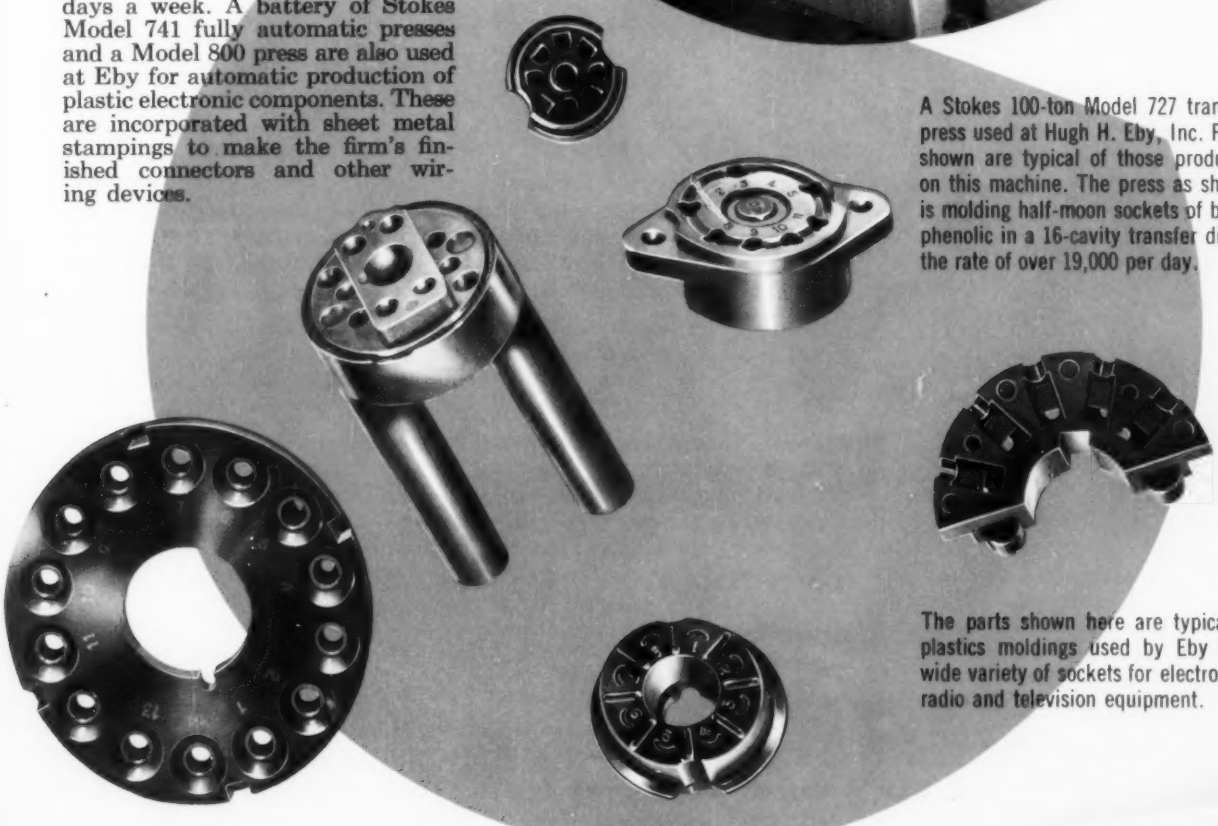
Eby Cuts Plastics Molding Costs with Stokes Automatics and Semi-Automatics

Hugh H. Eby, Inc. of Philadelphia, a large manufacturer of radio, television and electronics components and sub-assemblies, molds a wide line of plastic sockets, connectors, plugs, knobs and terminal blocks. Many of these parts are complex and require precise control of cycle times, pressures, and all other press operations for high quality production in quantity.

Eby uses a 100-ton Stokes 727 transfer press which is ideally suited for much of this intricate work. The Stokes patented Bar Controller makes press set-up a quick, simple operation requiring no elaborate adjustments. Buttons are moved on calibrated bars to control press actions and may be adjusted or reset even while the press is in operation. Once the settings are developed for each piece, they can be recorded so that when the particular part is needed again, the proper settings are easily made for quick press set-up and immediate production.

A Stokes Model R press prepares preforms for Eby's transfer press, which operates round-the-clock, 5 days a week. A battery of Stokes Model 741 fully automatic presses and a Model 800 press are also used at Eby for automatic production of plastic electronic components. These are incorporated with sheet metal stampings to make the firm's finished connectors and other wiring devices.

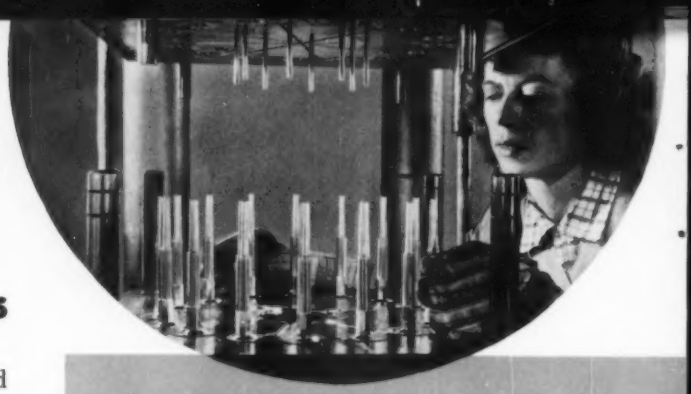
A Stokes 100-ton Model 727 transfer press used at Hugh H. Eby, Inc. Parts shown are typical of those produced on this machine. The press as shown is molding half-moon sockets of black phenolic in a 16-cavity transfer die at the rate of over 19,000 per day.



The parts shown here are typical of plastics moldings used by Eby in a wide variety of sockets for electronics, radio and television equipment.

STOKES

Ungar Electric Tools, Inc. Molds "Little Angel" Handles On Stokes Transfer Press



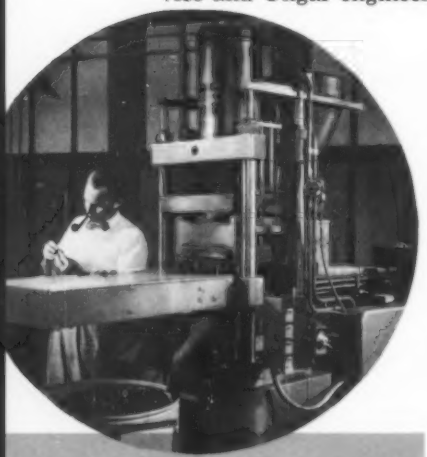
Plastic handles for Ungar Electric's "Little Angel" soldering irons are produced, 16 to a mold, on this Stokes Model 728 bottom transfer press.

Used in home workshops, laboratories and throughout industry for small soldering jobs, the Ungar Pencil Soldering Iron has earned itself the complimentary nickname "Little Angel" for its light weight and easy handling characteristics.

The feature of the Ungar iron, and its companion line of woodburning tools, is a durable plastic handle which is light in weight and remains cool during use. This handle is being produced at the rate of 3500 per day on a Stokes Model 728 bottom transfer compression molding press. The installation of the press in January, 1954 enabled this Venice, California, manufacturer to produce the part with a substantial saving in cost.

The correct combinations of mold design, cycle sequence and pressures were developed through cooperation between the Stokes Advisory Service and Ungar engineers. The separate pumping systems for the upper and lower rams on the 728 Stokes press, coupled with the patented bar controller, permit independent control of press speed and pressure for greater accuracy and maximum output.

The handles are produced on a two-minute cycle in an open pot transfer die with 16 cavities for molding the general purpose phenolic resin. The chief engineer of Ungar Electric Tools, Inc., Mr. A. R. Knowles, says that the Stokes press is the cleanest in operation that he has ever seen, which is in keeping with the modern appearance and spotless housekeeping of this manufacturer's new plant.



James Cullerton, sales manager of Mandex Manufacturing Co., checks radio tube sockets of black phenolic made on a 54-second cycle by a Stokes 741 automatic compression molding press. The press operates 24 hours a day, Saturdays and Sundays included, producing plastic parts for electronic components.

"Watchman, what of the night?"

Stokes Automatic Molding presses must get lonely at times . . . operating all day and throughout the night with only the occasional companionship of a night watchman. At Mandex Manufacturing Company in Chicago, for example, the hopper of the 50-ton Stokes press is filled by the night watchman when he comes on duty and then again when he leaves. Other than that, the press receives little attention, its hopper containing enough material for 23 hours of continuous production.

It's better off during the day, when the finished pieces have to be carted off to the production line where the electronic components are assembled. Then there is an occasional inspection to see that everything is running smoothly and that production quality remains high.

Of course, the lonely existence of this Stokes Model 741 press in the midst of a busy manufacturing plant means money in the pockets of its operators. In the case of a radio tube socket produced in quantity by Mandex, automatic operation reduced costs as much as 80%.

Mandex, founded in 1951, is a custom supplier and designer of electronic components for the radio and electronics industry. Through modern production methods, typified by the acquisition of the Stokes automatic compression molding press, the firm has more than tripled its production per man-hour in the last three years.

There's a catalog that gives detailed information on the Stokes Model 741 press that's yours for the asking—or check it on the enclosed reply card.

STOKES

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Radiation at Work

What the plastics industries are doing and planning

A SURVEY of plastics material makers and major processors indicates that all of the former and quite a few of the latter are conducting present research on the effects of radiation on various kinds of plastics. Several of the material makers have installed or are about to install their own radiation sources and facilities, in general using cobalt-60 as a gamma source. A few are purchasing electron generators or accelerators. The secondary processors, in the main, are using rental facilities for irradiation and conducting their tests in their own laboratories.

A vast silence extends over much of the present research at industry level, but the following statements from representative companies are reported here to indicate the trends.

American Agile Corp.—See full story, p. 103.

American Hard Rubber Co.—Has had samples of polyethylene treated and is currently running tests to develop cost and property data.

American Machine & Foundry Co.—Being fully aware of the basic advantages of using atomic energy to polymerize plastics, the firm is vitally interested in developing and supplying equipment for radiation processing. In addition to many tracer applications, radioisotopes have already found application in a nucleonic microfeed which AMF engineers have designed for use with their cigarette making machines. Current projects in AMF's Atomic Energy Department are centered around a "unitized" research reactor design. With this type of equipment, which would consist of relatively low-cost standardized reactor elements and configurations, universities and industry will be able to fit the requirements of widely differing basic specifications. The "unitized" or building block approach will permit conversion of ionization equipment from time to time to more modern and complex configurations.

Anchor Plastics Co.—This custom extruder is offering irradiated cross-linked polyethylene tubes, extruded shapes, and rods for testing and development programs. Doses of irradiation are to customer's specs.

Bakelite Co., Div. of Union Carbide and Carbon.—This company has been directly involved in atomic energy work since its inception, and has made several outstanding contributions to its development. Because of this, Bakelite has been fully advised as to the progress of nuclear work and its significance in relation to the plastics industry. As a result, new techniques have become available which are already simplifying and improving processing methods.

The use of tracer techniques has greatly simplified the study of reaction mechanisms, and has permitted accurate determinations which would have been impossible previously. This has shortened the time for completion of research and development phases of the processes of manufacture.

Radioactive thickness gages and similar instruments have simplified and improved control of mechanical processing operations.

Radiation as a catalyst for initiation of chemical reactions has become practical with the advent of cobalt-60 as a convenient source.

Radiation treatment of finished plastics products to obtain improved physical properties is certainly a demonstrated fact. At least one such product is on the market, but as yet no company product makes use of this effect.

Celanese Corp. of America.—Using tracer equipment for laboratory testing and development work.

Chicago Molded Products Corp.—Has done a limited amount of experimentation with a view to securing results of commercial value.

Diamond Alkali Co.—Using a cobalt-60 radiation source in the form of a hollow 2-in. pipe fixed in a 2-ton lead pig shield, this company will concentrate on vinyl type monomers and polymers in its irradiation investigations. The unit developed for Diamond Alkali by the people at Brookhaven National Laboratory contains a heat exchanger, which is a tubular coil surrounding the cobalt pipe. The heating or cooling liquid can be passed through the coil to control the temperature system, making it possible to carry out irradiation of any desired temperature. Another feature is that either batch or continuous sample irradiations can be carried out.

The Dow Chemical Co.—The company feels that any statement on the work it is doing on polymerization and copolymerization would be premature. An interesting application of radioactive tracer technique is in operation in the Saran Wrap Div. As the film comes from the extruder, it is difficult to gage mechanically because it is sticky until cool. By placing a small amount of shielded radioactive material below the film and a Geiger counter above it, a continuous gaging operation is obtained without touching the film.

General Electric Co., Chemicals Div.—Work on irradiated polyethylene films is described on p. 102. Details of developments at the Knolls Atomic Power Laboratory are not yet releasable.

The General Tire & Rubber Co.—The potential use of nuclear energy in industry is being closely followed by this company, particularly as this new form of energy applies to plastics and chemicals. From reports in research circles, nuclear energy applications in these fields will, in the future, change or transform basic chemical reactions, giving chemists and engineers new controls over product development.

Laboratory experiments meshing

(*To page* 216)

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PROTOTYPES from MATCHED PLASTICS DIES

Low-cost technique produces evaluation samples of reinforced plastics products which are equivalent to those made in matched metal molds

by DR. J. N. EPEL†

By molding prototypes of reinforced plastic chair-back on matched plastic tools, revisions in original design can be easily made before full-scale mass-production operations are started

MOLDERS in the reinforced plastics industry have frequently indicated the need for a method of obtaining accurate, inexpensive prototype parts which could be used for field and market testing. A technique for producing sample reinforced plastics parts which are equivalent to those produced in matched metal molds has been developed, utilizing matched plastic dies, to provide the engineer and designer with a direct method for pretesting their ideas and for determining proper wall thicknesses, radii, and structural reinforcements.

Engineering and design data, based on experience in the fibrous glass-reinforced plastics field, are as yet limited in scope. A wealth of experience-backed data are available for metal stampings, castings, and forgings, and rules of thumb can, therefore, be commonly used; nevertheless, samples of metal products are frequently made before production dies are constructed. Preproduction samples of reinforced plastics parts have been made by hand lay-up (zero p.s.i.) and vacuum bag molding (14 p.s.i.) techniques. But parts produced by these methods cannot be classed as prototypes, since the physical properties obtained will not be equivalent to those of the final parts molded in matched metal dies at 70 to 500 p.s.i. Lower glass content, lower filler loadings, and porosity generally characterize parts made by these techniques.

In an attempt to furnish its customers with prototype moldings identical in physical properties, wall thicknesses, dimensions, glass content, and densities with those of the final matched metal molded part, our company has developed the matched plastic molding technique. Molding pressures of 70 to 300 p.s.i.,

*Reg. U.S. Pat. Off.
†President, Duralastic Products Co., Detroit, Mich.

First step in making matched plastic dies is production of plaster model. Here sheet wax is applied to model and smoothed out (inset) to create proper molding edge

type of pinch-off, surface effects, and formulations are comparable for both matched plastic and matched metal molding. The major difference in molding technique is that matched plastic molding is carried out at room temperature and given a post-cure at 250° F.

The use of matched plastic dies enables a molder and his custom molding client to save two very valuable commodities during the experimental and development phase of getting a new product ready for production — time and money.

Matched plastic dies are advantageous for test work since die modifications can be readily made — within hours or days as compared with weeks or months in pattern or die shops — at very nominal costs; a market study of consumer reaction can be made with samples produced by this technique; parts can be field tested and modified before an investment is made in steel dies; preform versus die-cut mat can be tested; and compounding modifications can be evaluated on the actual part while the metal dies are being made, thereby saving development time after the final die is completed.

Articles molded in matched plastic dies by the Duralastic technique are almost indistinguishable from production parts and can, therefore, yield accurate field testing data. These parts are attractive enough to be used for show displays in order to test consumer reaction.

Plaster of paris male pattern is removed from completed phenolic female, using hammer and chisel. Wood pieces served as retainer box during pouring of the phenolic

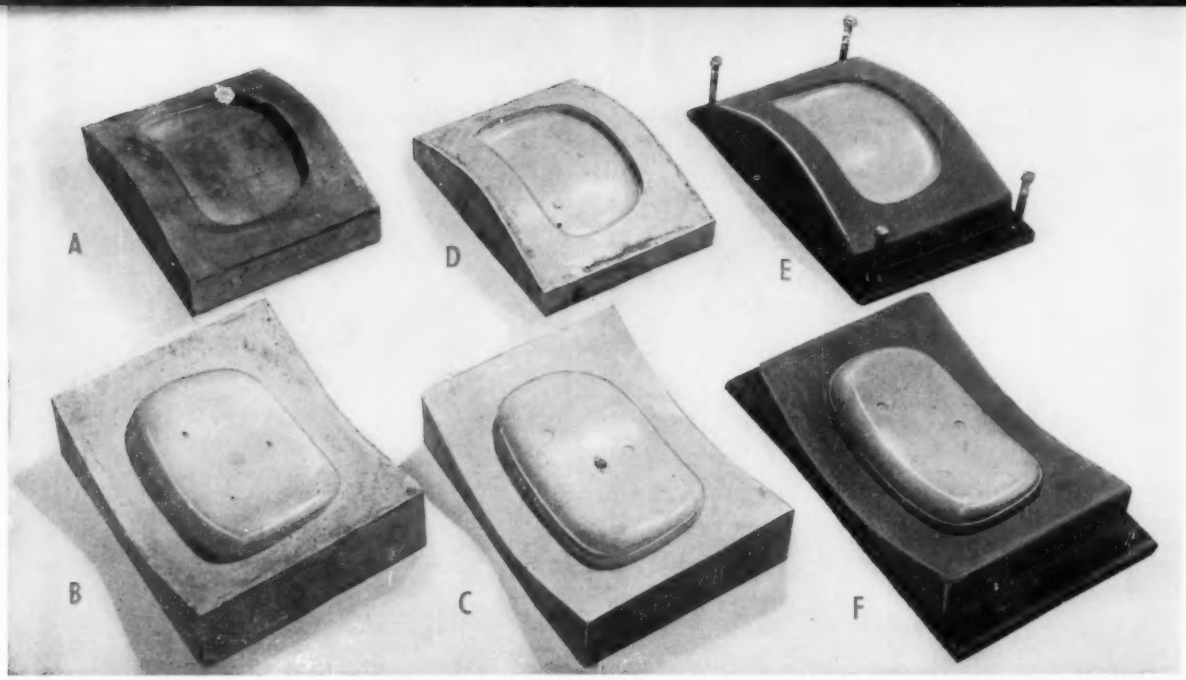
Case History

When Shwayder Brothers, Inc., Detroit, Mich., decided to manufacture a line of school furniture incorporating plastic chair-backs, they were faced with such questions as: which plastics, what wall thicknesses, what surface effects are obtainable, and what curvatures are required at the outer edges for optimal rigidity and strength?

Duralastic was asked to produce fibrous glass prototypes of the backs. Shwayder's chief engineer, Karl Steidtman, asked that these samples be produced by the matched plastic molding technique because he had been assured that, in addition to the evaluation he wanted of glass reinforced polyester for this application, accurate prototypes could be obtained and any design modification needed for successful molding in production could be incorporated in the sample parts.

An important consideration regarding the chair-back was the matter of the final appearance. During preliminary discussions, it was suggested that a part thickness of 0.093 in. would be adequate. There was some question whether this would be sufficient thickness from the standpoint of both rigidity and strength. There was the additional problem of whether this would be a sufficient thickness for fastening the back to the frame. To obtain answers to these questions, prototype parts were molded in matched plastic dies.

Samples from these dies answered the questions, and revisions in the



Male and female plaster patterns (A, B, C, and D) used to produce the two halves of a matched plastic mold (E—female, F—male). Details of the various steps involved in the actual mold-making operation are described in the text below

original design were made accordingly. While the steel dies were being made, 35 samples, representative of production parts, were required for the Chicago School Furniture Show. These samples were molded in the plastic dies.

The procedure used in preparing the Shwayder chair-back samples illustrates the Duralastic technique. The matched plastic tools were made using phenolic casting resins supplied by Reichhold Chemical Co. To date, the major portion of matched plastic tooling by Duralastic has been done with phenolic casting resins because of cost considerations. Epoxy casting resins have shown a great deal of promise and undoubtedly will have an increasingly important part in matched plastic prototype molding.

Mold-Making Steps

Since specifications and prints had not been prepared for the chair-back as a fibrous glass-reinforced plastics molding, Shwayder Brothers provided a plaster model with the desired contours. The edge of this plaster model in its original form was unsuitable for the construction of a die for molding fibrous glass reinforced plastics and, therefore, the edge of the model was first built up with sheet wax as shown in a photograph on p. 114. This build-up created a proper shearing edge, which, in this case, constituted a vertical edge on the part. Such changes also resulted in improved rigidity of the molded part.

The step-by-step procedure in producing the phenolic dies for these chair-backs may be described as follows, the key letters in the description linking to the photograph at the top of the page.

1) A plaster female (A) was taken off the model after it was revised by the addition of sheet wax to the edge as described in the preceeding paragraph.

2) A plaster male pattern (B) was taken from the plaster cavity A. This plaster male was the pattern against which the final phenolic cavity (E) was cast.

3) The plaster female (A), created as in step 1, was laid up with wax equal in thickness to that of the wall of the finished molded part.

4) A plaster male (C) was cast in the plaster female (A) after wax lay-up as in step 3.

5) A female plaster pattern (D) was cast against the plaster male (C) described in step 4. This female plaster is the pattern against which the final phenolic male (F) was cast.

Thus there had been created a female plaster (A), a male plaster (B), and a set of plaster patterns, male and female (C and D), with part thickness clearance. The final phenolic dies (E and F) were cast against the plaster patterns B and D. The plasters (A and C) resulting from steps 1 and 4 were kept in reserve for major modifications which could not be made directly on the phenolic dies, should they be needed, or should a phenolic die be accidentally damaged.

High Molding Pressures

Matched plastic dies must be subjected to high molding pressures (70 to 300 p.s.i.) to obtain parts equivalent to those molded in matched metal dies. It is, therefore, imperative that the cavity be reinforced in such a manner as to minimize tension forces. For parts of any appreciable depth, it is necessary to encase the plastic cavity in a rigid steel frame. For ease in handling and mounting to the press, it is desirable that both halves of the die be mounted on heavy steel plates. Duralastic's experience has indicated that the most direct method of preparing plastic dies is to cast the punch integral with steel mounting plates which have been prepared with anchor bolts and reinforcing rods for the purpose of providing a strong mechanical bond between the steel and the casting resin. The cavity is cast integral with back-up plate and steel retainer frame.

In the case of the chair-back, the

Polyester resin is poured onto glass mat placed on female half of phenolic mold. Operator holds surface mat which will cover fiber pattern

Fibrous glass-reinforced polyester chair-back prototype is removed from female half of phenolic mold after completion of molding cycle

Flash is removed from chair-back prototype by knife, and a file or sandpaper is used to smooth the edges. A stack of finished chair-back prototypes is at right

part was sufficiently shallow so that steel framing of the cavity was not required. On the other hand, the matched plastic dies for the production of prototypes of a Chrysler heater plenum chamber required a heavy steel retainer frame since the part was deep and the article was to be molded using Duramix S, a sisal glass-reinforced polyester molding compound. This part was molded at pressures up to 300 p.s.i.

The construction of the "pinch off" determines whether non-porous molded parts are obtained. In matched plastic dies, the telescope must be a minimum of 0.100 in. and should be constructed with a clearance at the pinch-off of 0.004 to 0.010 inch. Closer clearance often results in broken edges, larger clearances in too free a flow of resin so that a sufficiently high hydrostatic pressure cannot be built up within the die.

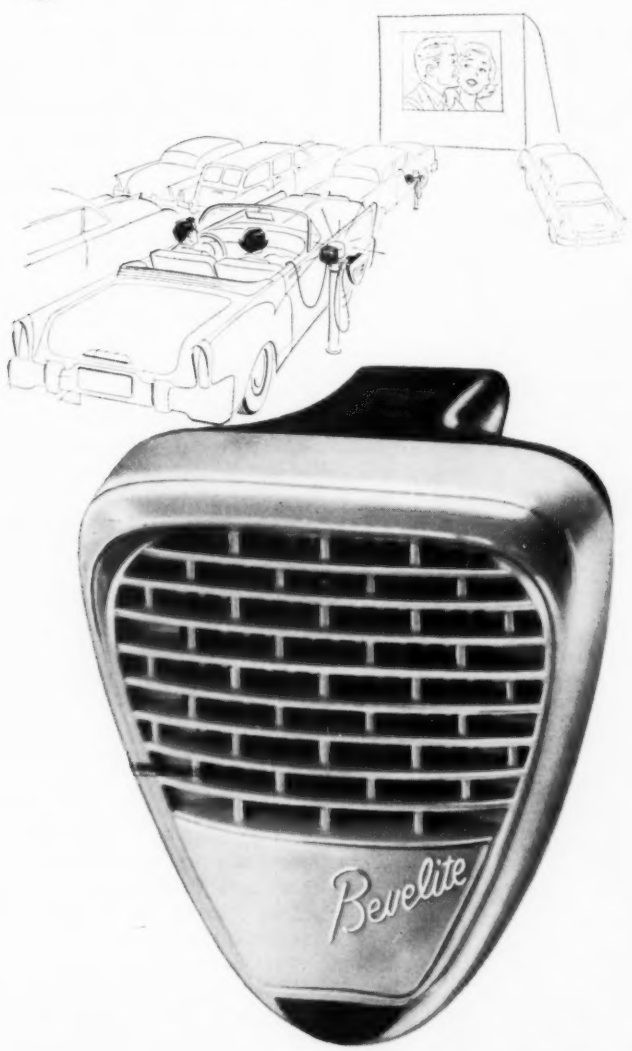
The dies are mounted in the press in the same manner as steel dies, with one important difference: The stops must be mounted external to the die, preferably on the mounting plates.

Die Correction

It is advisable that the plaster models be given a smooth finish prior to casting the plastic dies so that a minimum of sanding and patching need be done on the surface of the die. Porosity, pin-holes, and blemishes on the molding surface of the plastic dies can be corrected using a room temperature curing epoxy resin containing milled fibers as filler.

An important advantage of matched plastic molding over both vacuum bag and hand lay-up methods is that there are no severe limitations on the percentage of filler which can be used since cures are made under pressure up to 300 p.s.i. If, for reasons of physical properties or economics, it becomes desirable to mold parts containing up to 50% filler, this can be done. Thus, from the compounding standpoint also, prototype parts which are equivalent to those to be molded in matched metal dies can be made and field tested. Parts containing

good for long run



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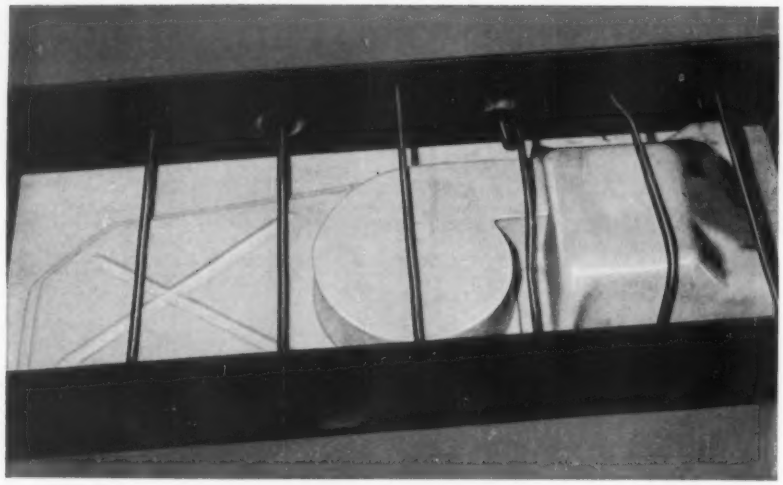
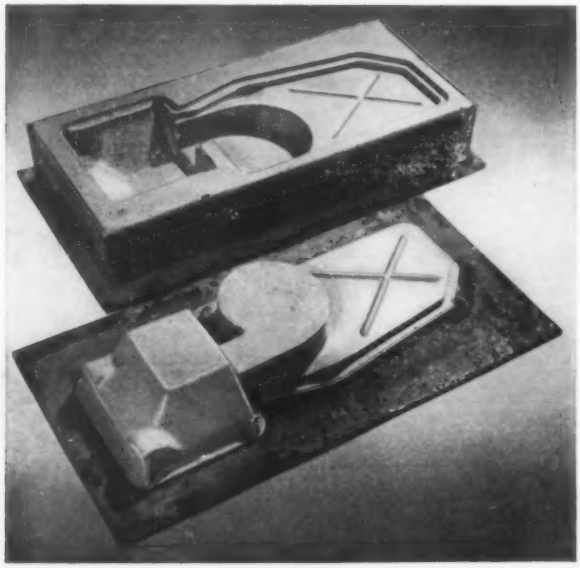


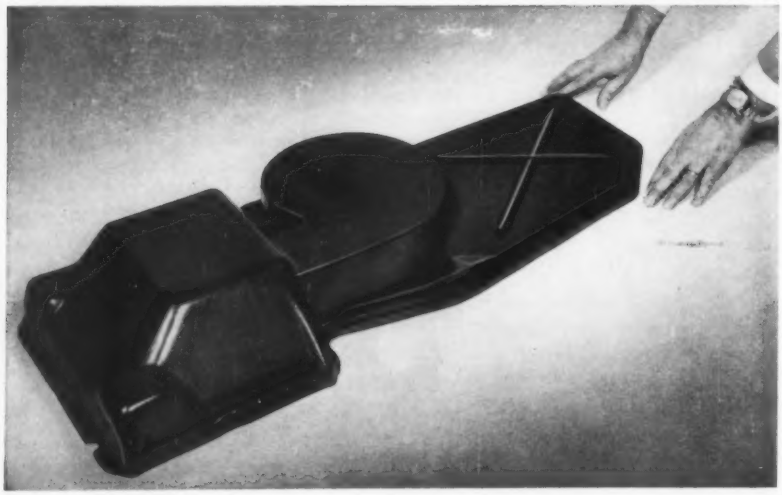
Large phenolic molds require steel reinforcement and bottom plate with holes for pouring and venting; steel frame-work above (without bottom plate) is on plaster male pattern



Female half (top) and male half of phenolic mold for producing reinforced plastics prototypes of a heater plenum chamber

Molded heater plenum chamber prototype. Molding compound from which it was made contained 50% clay as filler and chopped sisal and fibrous glass as reinforcement

All photos courtesy Duralastic Products Co.



50% carbonate filler have been molded by Duralastic with no apparent difficulty.

Premix molding compounds containing 50% clay as the filler and chopped sisal and fibrous glass as reinforcement, have been molded in matched plastic dies with no difficulty. This compound was used for the Chrysler heater plenum chamber.

Room Temperature Molding

Matched plastic molding is carried out at room temperature. A two-stage catalyst system is used. Cobalt-Lupersol DDM is used for the room temperature cure within the plastic die; benzoyl peroxide is included to insure the attainment of full strength when the parts are postbaked in the oven at 250° F.

When parts to be molded will not require subsequent painting, a single application of a paste wax, such as Simoniz, to the die is usually adequate to prevent sticking during the molding operation. When parts are to be painted, a water-soluble parting lacquer is applied to the die prior to each molding.

Matched plastic dies are equally effective for laminates containing mat or preform, or for parts using premix molding compounds. Time can, therefore, be saved by having auxiliary tools, such as mat cutting dies and preform screens, made while waiting for the matched metal dies to be completed. Assembly, finishing tools, and fixtures can also be prepared and checked during this waiting period.

Summary

A valuable aid for reinforced plastic molders and their custom molding clients has been developed in the form of matched plastic dies which will produce prototype parts equivalent to those molded in matched metal dies. Matched plastic dies are relatively inexpensive tools which can be made quickly and modified easily. Physical data, such as proper wall thickness, radii, and structural reinforcement requirements, can be determined from parts molded in matched plastic dies.

Because a method now exists for evaluating products quickly and inexpensively, many products still in the drawing board phase can now be considered for molding in reinforced plastics.

Molding Styrene SUPER Insulators

Radiation detection devices require insulators which approach the ultimate. Styrene pieces, molded under carefully controlled conditions, serve the purpose perfectly

by H. R. BROADLEY*

HEART of certain ionization chambers used as radiation detection devices is a super insulator which separates a charged metal probe from a surrounding conducting chamber. In order that charge leakage from the probe be kept to an absolute minimum, the insulator must be free of strains, cracks, surface pits, and, most important, dust and foreign material which would provide leakage paths for the static charge on the probe.

Figure 1 presents an exploded view of a pocket ionization chamber of the type developed by Dr. Francis Shonka at Argonne National Laboratories. From left to right are the plastic switch base, magnetic switch, collector probe and super insulator, and the case. Figure 2 is a sectional drawing of the assembled pocket chamber. The magnetic switch is contained in the switch base which consists of black polystyrene injection molded around the switch assembly. The complete unit is cemented into the conducting case and serves to position and secure the super insulator and conducting probe. The insulator must have an electrical leakage resistivity of between 10^{18} to 10^{20} ohms.

Fig. 1 (above)—Exploded view of pocket ionization chamber shows, left to right, switch base, magnetic switch, collector probe with insulator, and chamber covering

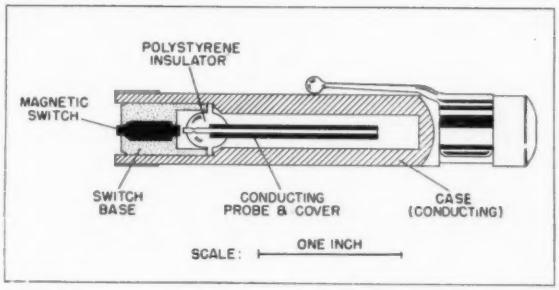


Fig. 2 (left)—Sectional drawing of assembled ionization chamber

Material and Development

Polystyrene has one of the highest surface resistivities of any of the common plastics. A high heat distortion grade, clear polystyrene was chosen for the super insulator. To minimize difficulties in the form of bubbles and flow lines, the polystyrene molding material was predried in a vacuum oven at 90° C. for 48 hr. and stored in a desiccator until used.

The highly polished mold was filled rapidly at high pressure by employing a modified Denison Ceramic press as an injection molding machine. Modifications to the press included the addition of a vertical

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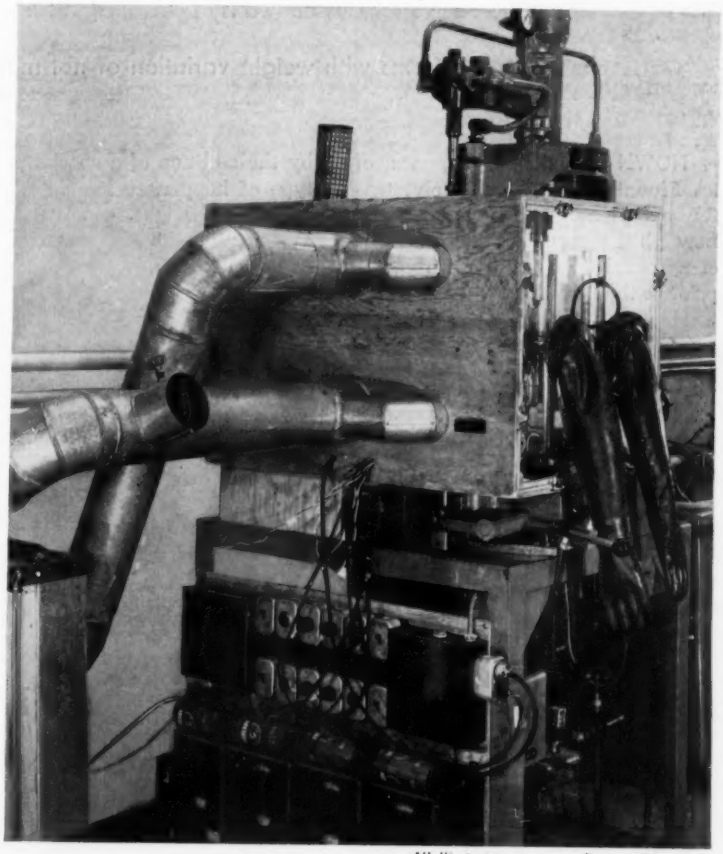


All illustrations courtesy General Electric Co.

Fig. 3—Experimental machine for injection molding insulator. Dust-tight plywood enclosure has transparent plastic window; operator's gloves are shown turned inside out

* Instrument Dept., General Electric Co.

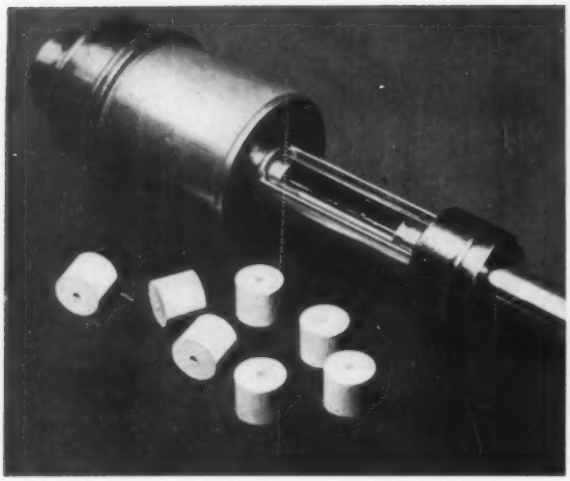
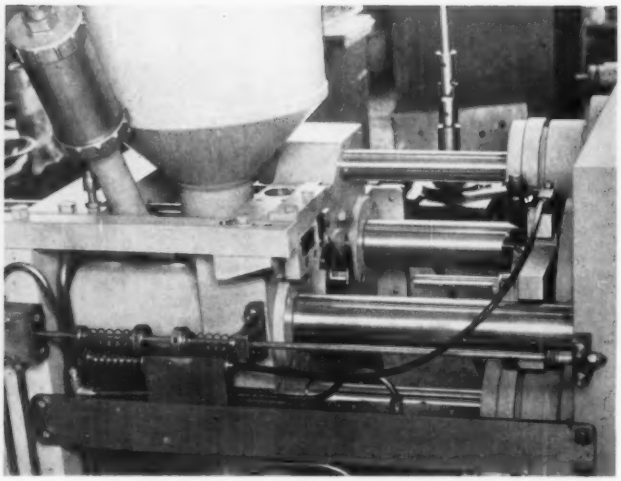


Fig. 1—Shutter device used for preforming polytetrafluorethylene solves die-filling problem due to material's bulk factor



Photos courtesy British Industrial Plastics Ltd.

Fig. 2—Agitator hopper used on polytetrafluoroethylene preforming machine is of standard type, is effectively used without modification

Preforming Polytetrafluoroethylene

Use of shutter device fed by special agitator type of hopper produces preforms with weight variation of not more than ±2 percent

KNOWN by the tradenames of Fluon[1] and Teflon,[2] polytetrafluoroethylene is a comparatively new plastic material that must be compressed into a preform shape prior to the final sintering step in the production of a molded piece. Because of the properties of the material, costly hand-weighing and hand-loading of the powder into the preform mold is usually required. Now, however, as the result of experimental work outlined below, it appears that such preforming can be successfully accomplished by automatic means and with satisfactory weight control.

During the past two years, development work on new preforming techniques with the Bipel[3] horizontal preformer[4] has resulted in the perfection of methods for producing a wide range of preform sizes and shapes from standard molding powders. It has also been found possible, by the addition of a special agitator type of hopper, to handle with remarkable weight consistency (± 3% medium-impact material, such as Bakelite 5073.

Agitator-Type Hopper

Coupled with a main ram device which applies pressure twice to each pellet, thus allowing trapped air to escape, the agitator type of hopper has made possible the preforming or pelleting of a range of fine ball-milled powders. This work is of special importance because the compacting of fine powder by automatic machinery is usually regarded as a different process.

Such successful performance of the horizontal preformer suggested that the techniques might also be applied to the usually difficult job of preforming polytetrafluoroethylene.

Compared with normal molding powders, polytetrafluoroethylene granules are of reasonably consistent size and there is little or no dust. Since conductivity of the material approaches zero (about 10^{17} ohms/cm.^{3}), and water absorption is virtually nil, any static charge tends to stay on the particles for an indefinite time. This means that the grains will cling to any surface and militates against the use of automatic weighing machines with vibrating hoppers. Even a normal scale pan presents difficulties in use, because the material will cling to its surface; when an attempt is made to brush it off, the material will stick to the brush.

Once in the die of the machine, however, polytetrafluoroethylene can be easily preformed with low pressure. In fact, it is possible to make a reasonably good preform, say of ½ in. diameter, by pressing the punch by hand. The pressure required is usually about 2000 p.s.i. and the pressure must be consistent if the dimensional accuracy of the finished product is not to suffer. This need for constant pressure makes a hydraulic machine essential, but the real difficulties in preforming lie in getting the powdered polytetrafluoroethylene into the die space.

The bulk factor of polytetrafluoro-

[1] Imperial Chemical Industries Ltd., Herts., Eng.
[2] E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
[3] B. I. P. Engineering Ltd., Sutton Coldfield, England American Representative, Ralph B. Symons Associates, Inc., Tiverton, R. I.
[4] Modern Plastics *30*, 136, (July 1953).

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ethylene is approximately 4.5:1. It is easy, therefore, to visualize the difficulties in making, say, a ring pellet of ½ in. diameter, ½ in. deep, with a central hole 0.11 in. diameter, on a conventional vertical machine.

This would entail filling a die ½ in. in diameter by 2¼ in. deep, having a central rod, with a powder that sticks to everything, including the central rod and the wall of the die. Even with careful hand-weighing of the material and filling of the die by hand, weight and volume will vary so much as to render it necessary to make the pellets oversize and shave them to size before the final sintering operation.

Horizontal Machine

In the early development work, it was clear from the outset that a horizontal machine was the best type for getting the die filled with the material, but experience had shown that the horizontal machine in its normal form would not carry powder into the die after the length/diameter ratio of the gap between the punches exceeded 4:1; that is to say, the amount of powder carried into the die increases as the gap between the punches increases until the length/diameter ratio of the gap reaches about 4:1. After this, there is no further increase of fill, even if the length/diameter ratio should reach 20:1. Despite this limitation, the standard horizontal machine will make a pellet with a length/diameter ratio of about 1.7:1, using a molding powder with a bulk factor of 2.

The problem put to Bipel was the production of a polytetrafluoroethylene pellet having a central hole 0.11 in. in diameter, the outside diameter being 0.531 in.; the weight was to be 3 g., which meant a pellet length of approximately $\frac{3}{16}$ in. and a loose powder length of at least 2 inches.

The filling problem was overcome by the use of a shutter device around the punches under the hopper which allows material to flow in between the punches, but which shuts before the movement of the hopper and die carries the material into the latter (Fig. 1). Once the cylindrical shutter closes, the loose powder space inside literally becomes an extension of the bore of the die and the material trapped is conveyed without loss into the die for compacting. Rotation of the shutter is effected by a rack-and-pinion mechanism operated by an air jack, in synchronism with the air pilot gear of the machine. The standard type of agitator hopper (Fig. 2) is used without modification and proves perfectly effective. The agitator mechanism (Fig. 3) consists of a set of blades in the conical base of a cylindrical hopper which feeds into a tube leading down to the filling space.

Fitted into the hopper is a mandrel driven by an electric motor that carries the agitator blades which are fitted close to, and which have the same shape as, the conical base. In addition, vertical agitator blades pass down through the feed tube to a point as close as possible to the shutter and the punches. The vertical agitator blades are adjustable in height so as to accommodate varying punch diameters. Continual rotation frees the powder from the walls and base of the hopper, and, as a result, material flows freely down to the filling space.

This combination of a shutter device and agitator blades has proved very effective. Polytetrafluoroethylene pellets of the required 3-g. weight can be made with a weight variation not exceeding ± 2% and it is possible to increase the weight up to 4 grams. The weight consistency of ± 2% indicates that "shaving off" can be dispensed with in regular production, an important advance in the technique of handling such a costly material as polytetrafluoroethylene.

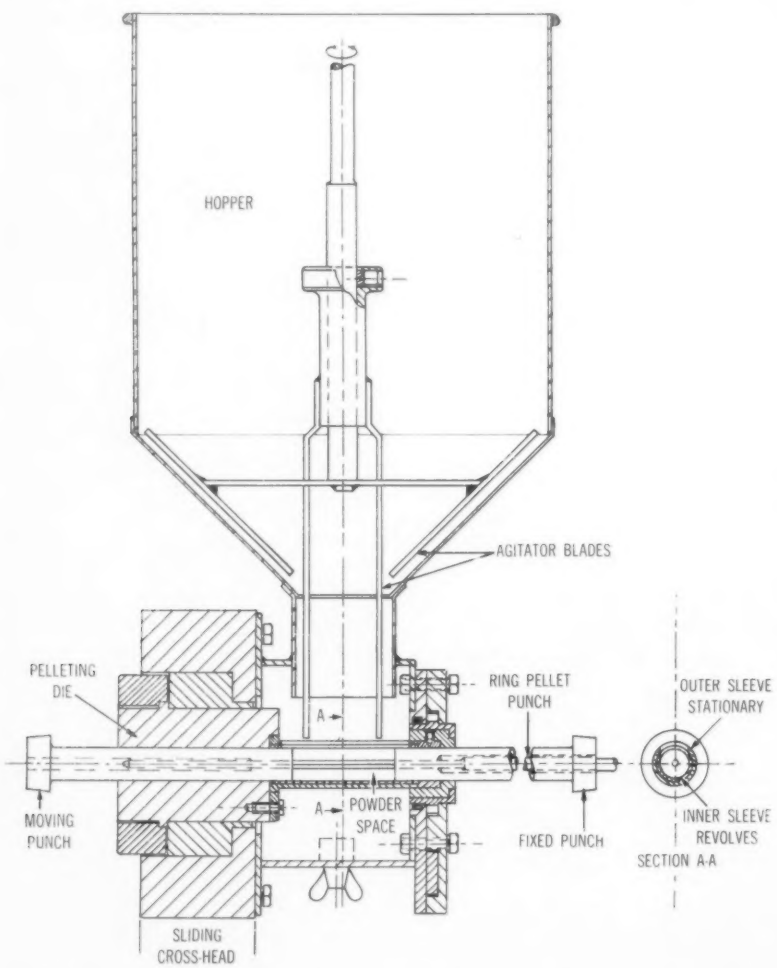

Fig. 3—Diagram of machine and hopper set-up for preforming polytetrafluoroethylene. Two sets of blades, one in hopper and one in feed tube, agitate the material

Acknowledgments

The trials on which the foregoing report is based were conducted by B.I.P. Engineering Ltd., with the cooperation of Imperial Chemical Industries Ltd., and British Mechanical Productions Ltd.

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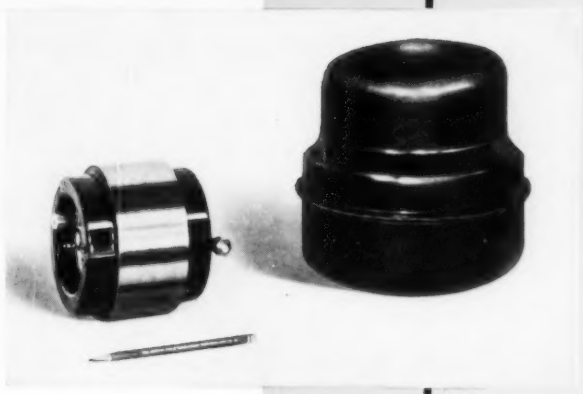
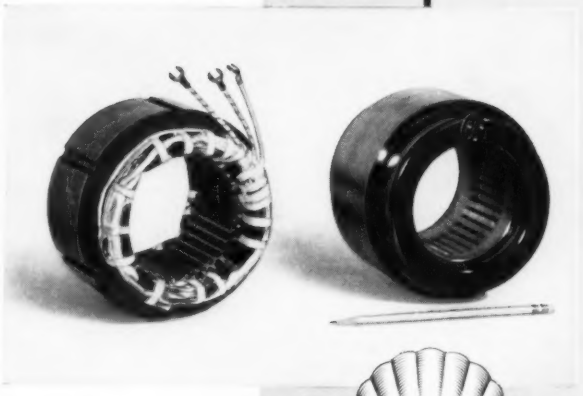


New Compressor (left) takes only 27% of the space of a conventional unit (right). It has only 10% as many parts, weighs 58% less, and will cost much less to produce.

Assembled stator (left). Finished stator (right) has been potted with Epon resin formulation. New compressor was developed by Wetmore Hodges and Associates, Redwood City, California.



Why not combine the pump and the motor? Put a gear pump *inside* the motor stator, encase the stator in plastic, and you can build an entire motor-compressor in the space occupied by a conventional motor alone!

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Fig. 1—Before being backed up by cast metal, plated mold for vacuum forming is cored with a network of metal tubing for the circulation of cooling water

Fig. 2—After cooling coils are properly located, a low-melting-point metal is cast into the plated mold shell

Molds for Vacuum Forming

Electroformed shells are backed up by cast metal, cored for circulation of cooling water

THERMOPLASTIC sheet can be vacuum formed on a male mold or in a female mold made from practically any material which will hold its shape when subjected to temperatures in the range of 300 to 400° F. Wood, plaster, cast and machined metals of many kinds, cast and machined plastics, and reinforced plastics are but a few examples.

The pros and cons regarding mold materials are many and often quite complex. Some of the materials have certain advantages and some have certain disadvantages. For example, plaster molds are cheap to produce but they are easily damaged. Although they can be repaired at low cost, a large number of rejects may be made before the mold defect is discovered, with costly results. Wood molds must be produced by expert model makers and are, therefore, quite expensive.

Molds Must be Cooled

In any event, no matter what material is used in molds for vacuum forming, their heat-conductive properties are of paramount importance. In production work, molds will gradually heat up as the forming operation continues from cycle to cycle if they are not cooled by some means, such as the application of a blast of cool air between each cycle or the use of a cooling medium circulated through suitable cores in the molds. Molds of wood, plaster, and plastic, however, do not tend to cool off sufficiently even when properly cored for cooling water, because these materials are such excellent heat insulators. The heat absorbed from the hot thermoplastic sheet being formed will not dissipate rapidly enough.

Molds of metal, however, when properly cored, will dissipate the

Fig. 3—For reproduction of fine detail, electroformed drape mold is made from a female master (left) which in turn has been electroformed on the original male model (right)

Photos courtesy Vacuum Sales Co.

heat rapidly. Most metal molds for vacuum forming are simply shells which are backed-up by some sort of cast material; the coring for carrying the coolant is a network of metal tubing inserted in this back-up material (see Fig. 1).

If the back-up material is not a good heat conductor, the advantages gained by coring will be eliminated. A plastic or plaster backing of any kind is therefore not recommended.

Just recently the old and well proved electroforming method of reproducing a shape in metal has been applied to the production of vacuum forming molds and is now being used by Vacuum Sales Co., Huntington Station, N. Y. The process, essentially the same as that used in producing phonograph record stampers, consists of electroplating nickel and copper onto a model which can be made of wood, plaster, plastic, metal, or, in fact, practically anything that will not deteriorate when immersed in electroplating solutions.

The only criticism heard to date about these molds is that every detail is reproduced so accurately that great care must be taken in preparing the model; any defects will be faithfully reproduced on the plated mold surface.

In order to take full advantage of the excellent heat conductivity of the plated mold shell, the back-up material used is a low-melting-point metal which is cast (Fig. 2) into the mold after the cooling coils have been properly located.

There are two classes of molds used in vacuum forming—1) a female mold which is produced from a male model, and 2) a male mold (used for drape forming) which must be plated out on a female model. Since practically all models are produced in the male form—because of the much greater simplicity of machining—it is necessary, if a drape forming mold is required, to produce a female model or master from the original male.

If fine and intricate detail is not required in the vacuum-formed part, a female master may be cast from the male model in plaster or plastic. This cast female is then used for the production of the final male mold. If, on the other hand, fine detail is required, it is generally necessary to electroform a female (Fig. 3) master on the original male model. This in turn is then used for producing the final electroformed drape forming mold.

When a female vacuum-forming mold is required, this, of course, can be plated out directly from the original male model.

The technique of producing electroformed mold shells, described below, requires careful attention to detail.

After the model has been delivered, it is first carefully cleaned to be sure that no dust or dirt is on the surface. It is then given a bath of stannus chloride and washed off with clean water. The next step involves sensitizing its surface.

This sensitizing consists of producing on the surface of the model a coating of pure silver by chemical reduction. Two solutions are prepared. One solution consists of ½ pt. of silver ammonium hydroxide and ½ pt. of a mixture of sodium hydroxide and ammonium hydroxide, all chemicals being in concentrated

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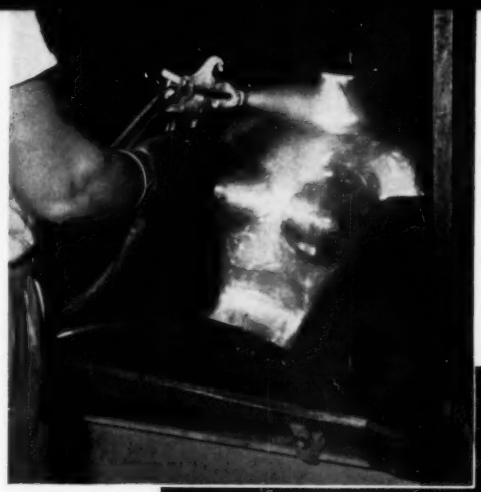

Fig. 4—Model is sensitized by simultaneously spraying two solutions which react to form thin silver deposit on its surface

Fig. 5—Sensitized model, with necessary anodes properly attached to it, is immersed in standard nickel plating bath

Fig. 6—Finished shell is removed from male model after both nickel- and copper-plating operations have been completed

Photo courtesy Majestic Creations, Inc., Woodside, L. I.

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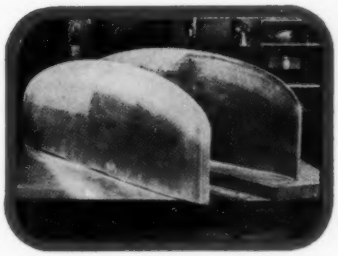

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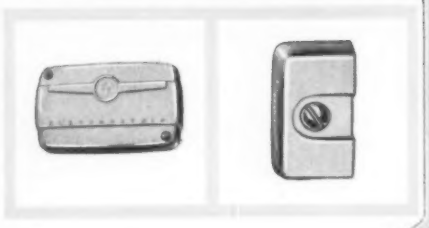

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PLASTICS*
TECHNICAL SECTION: Dr. Gordon M. Kline, Technical Editor

The Caplastometer:

A New Melt Viscometer

Factors that must be considered in measuring the melt viscosity of polymers are discussed. A description of a proposed rheometer to meet these requirements is given. This rheometer can be operated at temperatures and shear rates comparable to those found during injection molding and extrusion. Methods of plotting and interpreting the data are presented. The use of the Caplastometer for evaluating and studying the flow behavior of linear polymers is described.

by H. J. KARAM,† K. J. CLEEREMAN,† and J. L. WILLIAMS†

RHEOLOGICAL properties are important factors that must be considered in the study of high polymers. Many types of rheometers have been used or are currently being used to evaluate such properties (Table I). The construction and operation of these instruments are given in the literature references indicated in the table.

All the instruments listed in Table I have some or all of the following disadvantages:

1) Flow properties are evaluated in limited ranges of temperature, shear, and shear rate.

2) The ranges of shear, shear rate, and temperature are below the range in which the plastic is fabricated.

3) Reproducibility is fair to poor.

4) Elaborate sample preparation is required.

5) Correlation of data with end use is poor.

6) Operation of the rheometer is difficult.

7) Sample must be kept in the viscometer for such a long time that degradation, cross-linking, or branching occurs.

To meet these objections another capillary-type viscometer has been developed.

Figure 1, p. 130, is a schematic sketch of the capillary rheometer. The instrument is called a "Caplastometer," based on the phrase "capillary-type plastic rheometer."

The unit consists of a steel cylinder with a 0.5-in. bore. As shown in Fig. 1, p. 130, the cylinder is referred to as the rheometer tube and the bore as the tunnel. An orifice or capillary is situated in the central portion of the tunnel. A plastic slug approximately 2 in. long and ½ in. in diameter is placed in the bottom tunnel of the rheometer. After temperature equilibrium is attained, pressure is applied to the molten plastic by means of a nitrogen gas system. Thus, the material is forced from the bottom tunnel through the orifice into the upper tunnel. The rate of extrusion of the plastic through the capillary is measured by following the motion of the top piston. The plastic is then forced back to the bottom tunnel by means of an air piston. This procedure is repeated over a range of shear stresses. Knowing the extrusion rate, one can compute the apparent viscosity for any shear stress.

Operation of Rheometer

Heating of the Plastic—The flow of polymers is very sensitive to temperature. It is, therefore, important that the plastic be heated to a uniform temperature before flow measurements are made. This proved to be a major problem in the design of the rheometer. At present, electric heaters are used in conjunction with a controller. By arranging the heat-

Table I—Types Of Plastic Rheometers

Type of rheometer	Description	Literature reference
Rossi-Peake flow tester	Capillary type. Measures time for a given distance of flow.	(1)[a]
Melt index	Capillary type. Measures extrusion rate for fixed load.	(2)
Nason	Capillary type. Measures rate of extrusion over a wide range of shear.	(6)
Coaxial	Plastic is sheared between two concentric cylinders. A low rate of shear is used.	(5)
Rotational	Plastic is sheared between two concentric cylinders. The force for a given rate of shear is measured. Plastic is sheared over a wide range of shear rates.	(3)
Williams flat plate	Plastic is placed under load between two plates. The rate of deformation is measured.	(4)

[a] Numbers in parentheses link to references at end of article, p. 226.

* Reg. U. S. Pat. Off.

† Styron Inspection and Service Laboratory, The Dow Chemical Co.

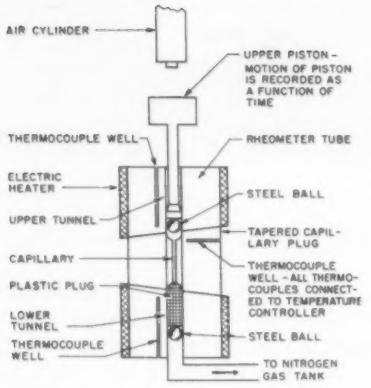

Fig. 1—Schematic diagram of caplastometer. Pressure of tank can be regulated from 0 to 2200 p.s.i.

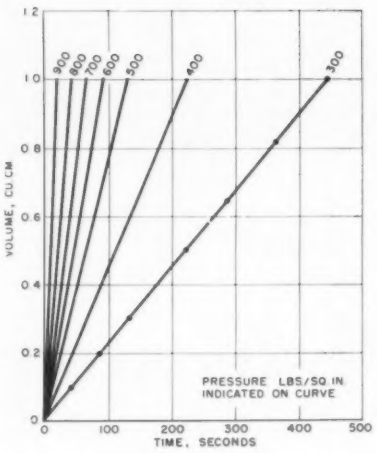

Fig. 2—Volume of polymer flow vs. time

ers so that half are on continuously and the other half controlled, the temperature of the bore can be regulated within ±3° F.

Heating Time—The calculated time required for the plastic to reach temperature equilibrium is 2½ minutes. This calculation is based on a number of assumptions which may or may not be true. Therefore, to insure uniform plastic temperature two precautions must be taken: 1) the plastic slug is left in the tunnel for 10 min. before the run is made; 2) the plastic slug is worked back and forth through the capillary at least five times during the warm-up period of 10 minutes.

Pressure System—A nitrogen gas pressure is used to extrude the plastic through the capillary. Nitrogen was chosen because it is inert. To prevent channeling of the gas and seepage of the plastic back into the gas line, a close-fitting steel ball was inserted in the bottom tunnel. With this set-up, results are reproducible over a wide range of pressure, as illustrated in Table II.

A well-regulated tube temperature in conjunction with a gas pressure system results in a linear flow curve. Figure 2 shows a series of flow curves for general-purpose polystyrene over a wide range of shear. Note that the rate of flow (slope of the flow versus time curve) is constant for any fixed shear.

Flow Measurements—The flow of the plastic through the capillary is measured by following the motion of the top piston as a function of time. It is important that the plastic does not seep along the side of the piston and cause it to bind. To minimize this possibility, a steel ball was closely fitted in the upper tunnel. The dimension of the ball is of the order of 0.0002 to 0.0004 in. less than the diameter of the bore. The fit of the upper piston is loose as compared to the fit of the ball. With this arrangement binding and flashing are minimized.

The rate of motion of the top piston is measured by means of Microswitches and an electric stop watch arrangement. Provision is made to check the linearity of flow.

Capillary Plug—An important requirement of a plastic rheometer is the ability to measure the flow properties of various plastics over a wide range of shear and shear rate. To accomplish this, it is important that the flow through various size capillaries be studied. The Caplastometer lends itself quite readily to this type of investigation. To change capillaries with this unit, one merely changes plugs. A series of plugs are made up with various orifice dimensions. The plug shown in Fig. 1 is removable and is held in place by means of a self-locking taper.

Time—the time required to prepare a sample and make a run is an important consideration in the operation of a rheometer. These factors for the Caplastometer are summarized in Table III.

Advantages of Plastometer

The desirable features of this rheometer may be summarized as the following:

1) Flow properties can be evaluated over a wide temperature range (200 to 600°F.).

2) Polymers of a wide range of fluidity can be evaluated.

3) Flow properties can be evaluated over a wide range of shear.

4) Reproducibility is ± 3 percent.

5) Flow properties of polymers in the range of fabricating conditions can be evaluated.

6) It can be used for quality control testing.

7) Only a small sample of polymer is required for evaluation purposes.

8) A wide range of polymer types can be evaluated.

9) It is a versatile laboratory type of instrument.

Plotting of Data

Table IV, p. 132, list the formula for computing the shear, shear rate, and apparent viscosity from the ob-

Table II—Reproducibility of Results

Material: general-purpose polystyrene
Volume extruded: 3.7 cm.³
Plastic temperature: 440° F.
Capillary dimensions: diameter 0.040 in.; length 1 inch.

Shear at wall	Extrusion time[a]	Range
10^5 dynes/cm.²	sec.	sec.
4.12	438	6
5.50	230	0
8.24	130	0
9.60	78	0
11.0	53	2
13.8	37	0

[a] Average of three consecutive runs.

Table III—Sequence of Operation

Operation	Time
Specimen preparation	None. Granules can be used. Weight of polystyrene specimen is 8 g.
Time to load	2 min.
Time for sample to reach equilibrium	10 min.
Time to run sample	30 to 40 min.
Time to clean apparatus	20 min.
Time to plot data	Data are plotted during warm-up period.
Total time required	72 min.

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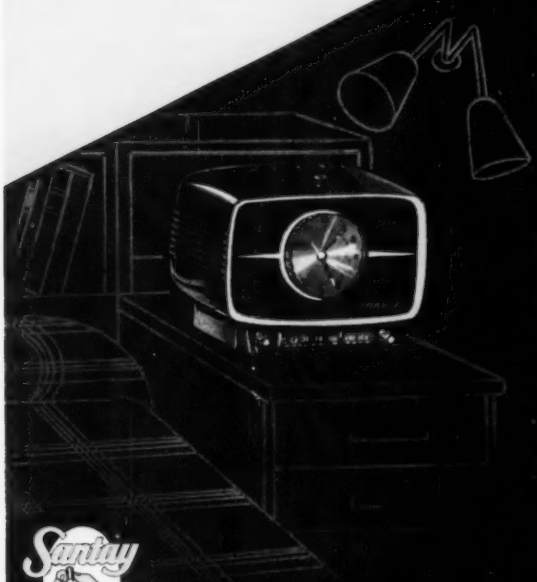

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Table IV—Equations for Computing Shear, Shear Rate, and Apparent Viscosity

Equations	To Compute
1. $\eta_A = \frac{\pi R^3 \tau_W}{4Q}$	Apparent viscosity
2. $\varphi_A = \frac{1}{\eta_A}$	Apparent fluidity
3. $f(\tau_W) = \frac{1}{\pi R^3}[3F(\tau_W) + \tau_W F^1(\tau_W)]$	Shear rate at wall
4. $\tau_W = \frac{PR}{2L}$	

τ_W = Shear stress at wall; $F(\tau_W)$ = Flow function (plot of Q versus τ_W)

η_A = Apparent viscosity; $F^1(\tau_W)$ = First derivative of flow function

φ_A = Apparent fluidity; P = Pressure drop

Q = Extrusion rate; R = Radius of capillary

$f(\tau_W)$ = Shear rate at the wall; L = Length of capillary

served data. Definitions of the symbols used are given in the table.

Data observed can be plotted in two ways, fundamentally and empirically. The fundamental approach of plotting data is to obtain the consistency curve from the observed data. The consistency curve is defined as the shear rate versus shear plot. An example of a fundamental plot of data for a polystyrene sample is shown in Fig. 3. These curves were obtained from the observed data by a method proposed by Rabinowitsch (7,8)[1] and computed by use of equation 3 of Table II.

As shown in Fig. 3, the shear and shear rate plots were obtained for a range of temperatures. The curves of Fig. 3 illustrate the typical non-Newtonian behavior of most linear high polymers. For Newtonian materials these curves will be a series of straight lines, the slope of which is equal to the fluidity of the material.

As shown in Fig. 3, the data cannot be evaluated by any known simple equation. An empirical approach must be used, based on a method proposed by R. S. Spencer (9). The method consists of plotting the "log of the shear stress at the wall" (computed by use of equation 4 of Table IV) versus the "log of apparent fluidity" (computed by use of equation 2 of Table IV). The experimental points are fitted to a theoretical curve which is drawn on a transparent celluloid sheet. This is accomplished by translating the celluloid template along the "X" and "Y" axis. The "X" and "Y" intercepts of the two reference axes drawn on the template give η_0 and $1/k$, the two constants that describe the rheological properties of the polymer (see Fig. 4).

η_0 is defined as the zero shear viscosity, that is, the viscosity of the material if it were Newtonian; $1/k$ is a constant expressing the extent of deviation from Newtonian behavior. The units for η_0 are poises and for $1/k$ are dynes per square centimeter.

In addition to the two constants, η_0 and $1/k$, a third constant η_7 is used in our laboratories to evaluate stiffness of polymers. η_7 is defined as the apparent viscosity of a plastic at a shearing stress of 700,000 dynes per square centimeter. The shearing stress range of an injection molding machine varies over a wide range. It appears that 700,000 dynes/cm.^{2} represents the average shear stress for fabricating polystyrene in an injection molding machine. It is important in correlating data with injection molding performance to know the shear-stress range of the machine.

An important aspect in operation of the rheometer is the reproducibility of data. Table V, p. 134, gives the range, standard deviation, and coefficient of variability of ten consecutive runs using the Caplastometer.

Applications of Rheometer

Rheological Properties of Polymers—Two important factors that must be considered in studying the flow properties of polymers are the temperature and pressure of extrusion. The Caplastometer is suitable for such a study. Figure 5, p. 134, shows a plot of the zero shear viscosity versus temperatures for a series of linear polymers. Table VI, p. 134, gives the $1/k$ factors for these polymers; this factor is independent of temperature in the range studied. Physically, it means that if the viscosity versus shear curves are plotted, one has a family of curves

Fig. 3—Rate of shear at the wall vs. shear strength at the wall. Material: general-purpose polystyrene

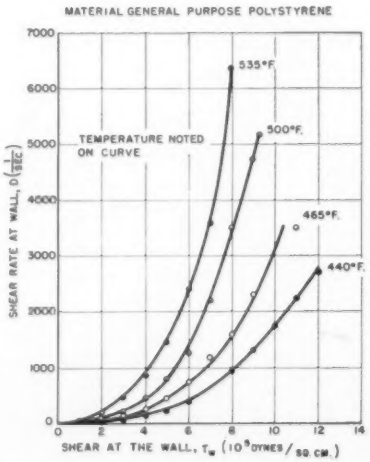
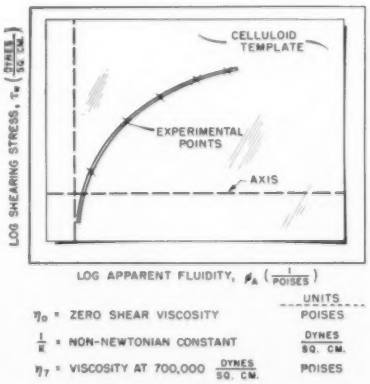


Fig. 4—Plotting melt viscosity data. Experimental points are fitted to a theoretical curve drawn on a transparent celluloid sheet. Method of obtaining constants is at bottom


CELLULOID TEMPLATE
EXPERIMENTAL POINTS
AXIS
LOG SHEARING STRESS, τ_w (DYNES/SQ. CM.)
LOG APPARENT FLUIDITY, φ_A (1/POISES)
η_0 = ZERO SHEAR VISCOSITY — UNITS POISES
$1/k$ = NON-NEWTONIAN CONSTANT — DYNES/SQ. CM.
η_7 = VISCOSITY AT 700,000 DYNES/SQ. CM. — POISES

[1] Numbers in parentheses link to references at end of articles, p. 226.

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(2) *Activated Carbon — Specimen 20 mils thick*
(3) *Method of E. F. Schulz, ASTM Bulletin No. 183, July 1952, p. 75*

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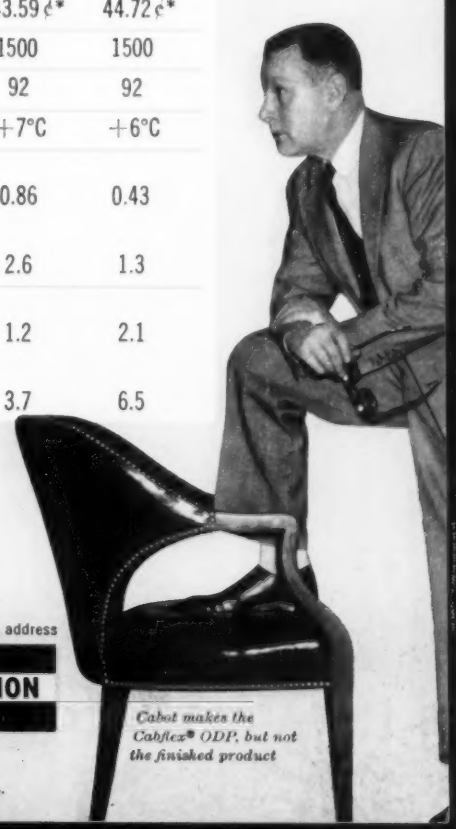

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Table V—Reproducibility of Data

Material: general-purpose polystyrene
Plastic Temperature: 440° F.

	η_0	η_7	1/k
	poises	poises	10^5 dynes/cm.^{2}
Average	27000	2900	3.0
Range[a]	2000	100	0.10
Standard deviation (σ)[b]	650	50	0.05
Coefficient of variation[c]	2.4%	1.7%	1.7%

[a] Range is the difference between highest and lowest value in a series of values. (Not too good when there are more than ten values.)
[b] Standard deviation is the root mean square deviation of the numbers from their average.
[c] Coefficient of variation is the standard deviation expressed as a percentage of the average.

that have the same slope but are displaced along the horizontal axis.

Effect of Plasticizer—In this investigation the effects of two types of plasticizers were evaluated. Plasticizer A has non-Newtonian flow properties and plasticizer B has Newtonian flow properties. The results on the flow properties of the polymer are shown in Fig. 6. Both materials lowered the melt viscosity of the polymer, with plasticizer B having a greater effect than plasticizer A. An important difference is that the sample plasticized with A is more shear sensitive. Shear sensitivity is defined as the ratio of the change of viscosity to shear stress.

The effects of the two plasticizers on the flow viscosity of the polymer are consistent with theory. A Newtonian plasticizer has a lower viscosity and is not shear sensitive. These characteristics of the plasticizer are imparted to the polymer. Conversely, a non-Newtonian plasticizer is stiffer and is shear sensitive; hence, the flow of the plasticized polymer will be affected in a like manner. It is important to note that the type of information illustrated by Fig. 6 cannot be obtained with a single point determination of flow properties.

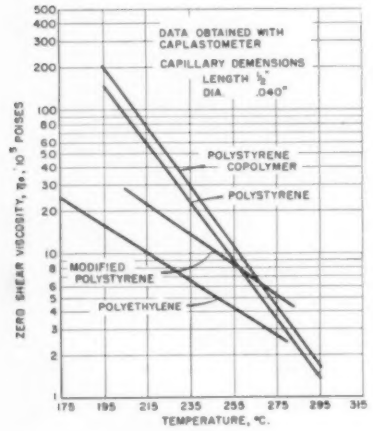


Fig. 5—Zero shear viscosity vs. temperature

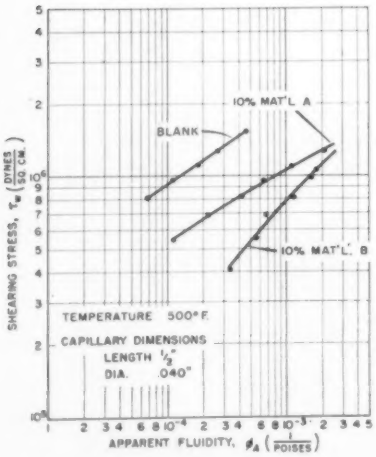


Fig. 6—Melt viscosity of styrene plasticized with materials A and B

Table VI—Non-Newtonian Constant for Some Linear Polymers

Material	1/k
	10^5 dynes/cm.^{2}
Polystyrene	2.8
Polystyrene copolymer	8.2
Polyethylene	8.2
Modified polystyrene	3.2

NOTE that polystyrene has the lowest 1/k factor. Physically, it is more non-Newtonian in flow properties than the other polymers.

Correlation of Melt Viscosity With Molding Machine Variables—Preliminary work has been initiated to determine the correlation of melt viscosity data with injection molding variables. Typical of such an application is the correlation of melt viscosity as obtained with the Caplastometer, with injection molding short-shot data. Short-shot is defined as the minimum pressure to fill a mold at one temperature. The results of this investigation are shown in Table VII.

Effect of Temperature on Polymer Structure—Polymers, when heated, can cross-link, branch, or degrade. The Caplastometer can be readily adapted to study such behavior. This is accomplished by extruding the polymer in the viscometer under a fixed shearing stress as a function of time. If the material cross-links, branches, or degrades, the flow viscosity will change depending on which mechanism predominates. Cross-linking or branching increases, degradation decreases flow viscosity.

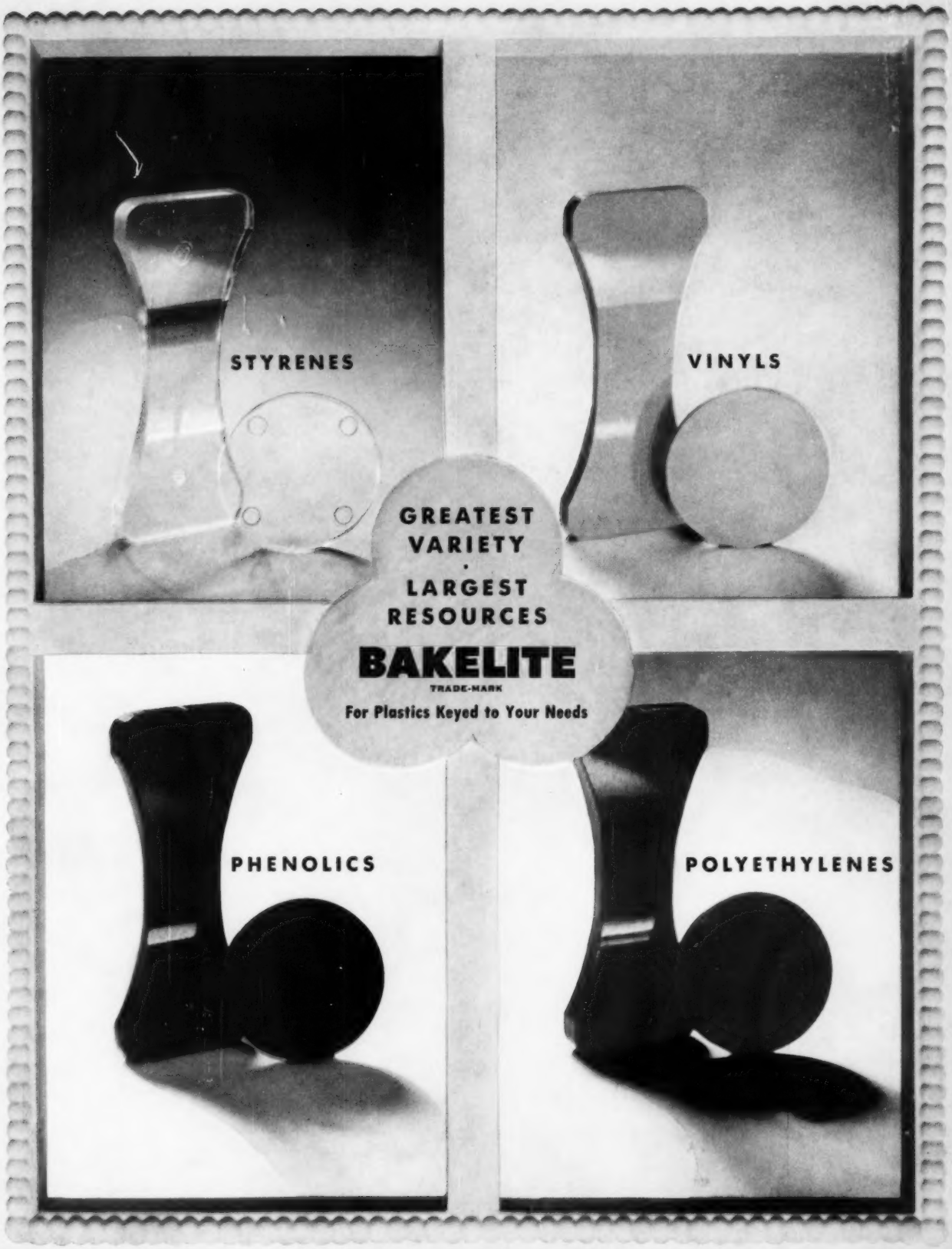
A typical investigation to study the flow behavior of heated linear polymers is shown in Fig. 7, p. 226. Polymer A was unaffected by heating in the viscometer. Viscosity of polymer B increased with heat indicating that the material was either

(*To page* 226)

Table VII—Comparison of Melt Viscosity Data and Ability To Fill Mold

Sample	1/k	η_0	η_7	Rating by melt viscosity[a]	Injection pressure[b]	Rating by injection molding test[a]
	10^5 dynes/cm.^{2}	poises	poises		p.s.i.	
Polymer A	3.8	17,000	2,900	1	14,000	1
Polymer B	3.6	18,000	2,900	1	14,000	1
Polymer C	4.1	24,000	4,600	2	16,000	2
Polymer D	5.1	21,000	5,900	3	18,000	3
Polymer E	8.0	39,000	16,000	4	>20,000	4

[a] No. 1 is most fluid. [b] Injection pressure to fill at 630° F. machine temperature.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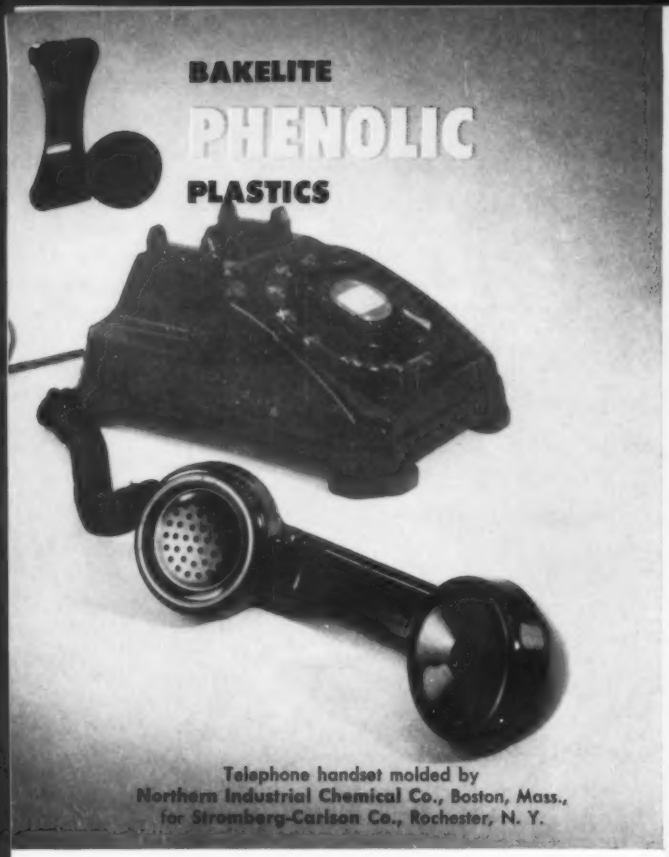

Telephone handset molded by
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for Stromberg-Carlson Co., Rochester, N. Y.

Pick up this telephone handset, and you'll be impressed by its beautiful design and beautiful molding—the result of making it from BAKELITE Brand Phenolic BMG-5000 Black 25.

The good preheating latitude of this material permits considerable delay in transfer time from preheat to mold closing without pronounced knit, weld, or flow lines resulting. It can be molded over a wider time range than other general-purpose phenolics, and fast curing speed is obtained with all molding techniques.

BMG-5000 Black 25 provides an attractive black surface with excellent gloss. Rigid BAKELITE quality control assures blend-to-blend uniformity.

Electronic parts molded by
U. S. Gasket Co., Camden, N. J.

These little seals, connectors, and insulators owe their success in the electronics field to the material they're made from—BAKELITE Brand Fluorothene. It's one of the most durable plastics commercially available.

BAKELITE Fluorothene works in temperatures from 390 deg. F. down to −320 deg. F. It's resistant to burning, weathering, chemicals and corrosive atmospheres—even fuming nitric acid. Hammer blows on it hardly leave a mark. It shows no moisture absorption and has excellent electrical properties.

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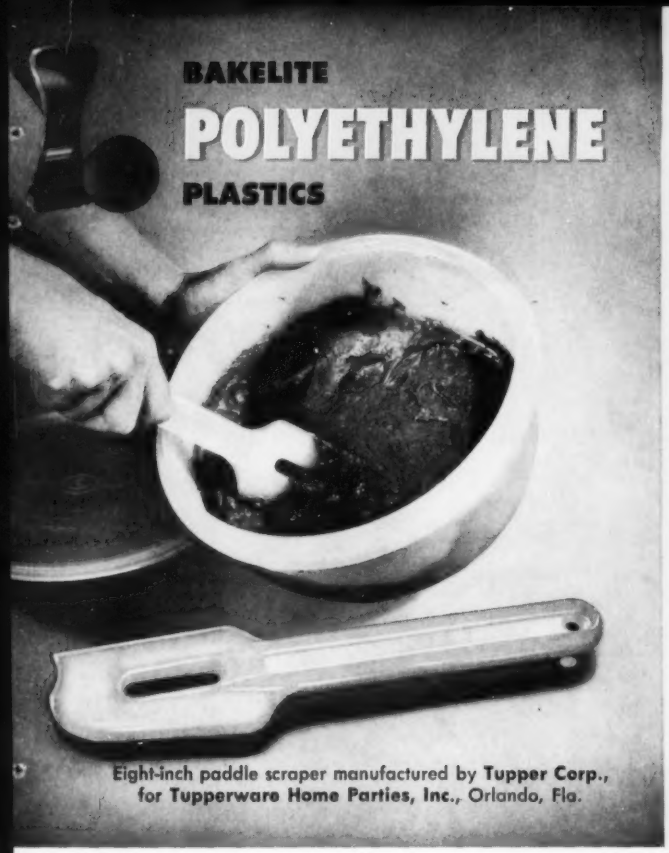
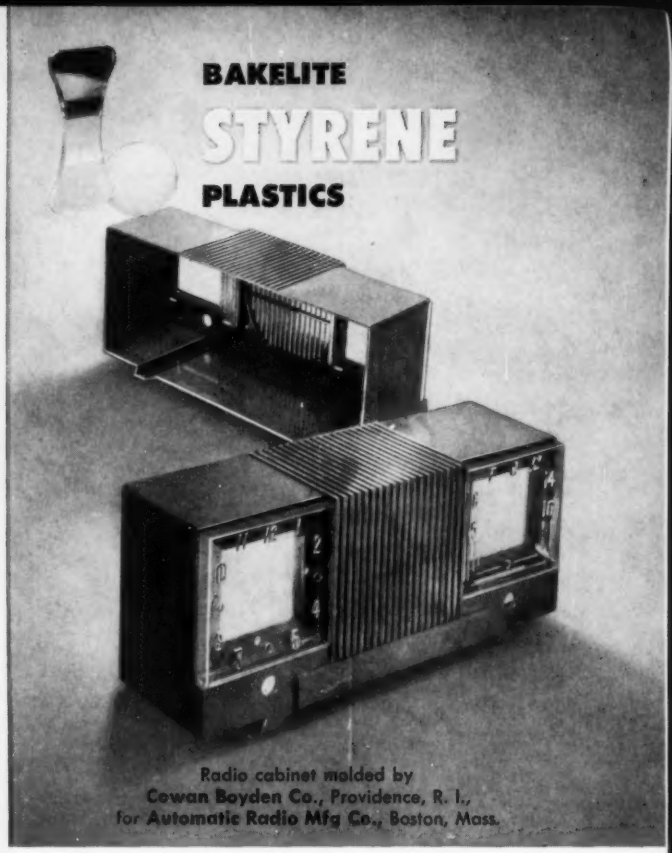


Eight-inch paddle scraper manufactured by **Tupper Corp.**, for **Tupperware Home Parties, Inc.**, Orlando, Fla.



Radio cabinet molded by **Cowan Boyden Co.**, Providence, R. I., for **Automatic Radio Mfg Co.**, Boston, Mass.

You can get a good idea of the product design possibilities in BAKELITE Brand Polyethylene even from this simple kitchen tool. It's a paddle scraper used for mixing and stirring. It's tough and flexible . . . resistant to water and foods. The irregular shape suggests the variety of molded designs possible with BAKELITE Polyethylene. It won't break, and there's nothing to come apart, since it's molded in one piece.

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Two BAKELITE Brand Styrene Plastics were used to make this clock radio cabinet. SMD-3000, used for the main section, has a high heat distortion point of 197 deg. F. as measured on an unannealed test bar. And you can see the clean sharp details and glossy finish it takes in molding. SMD-3000 has the same color range as other styrenes.

The other BAKELITE Styrene Plastic, SMD-3500, is used to mold the crystal-clear dial lenses. Its easier flow at mold temperatures permits either faster molding or the use of lower temperatures than are needed with other general-purpose styrenes. In one field test, it cut the molding cycle 50 per cent.

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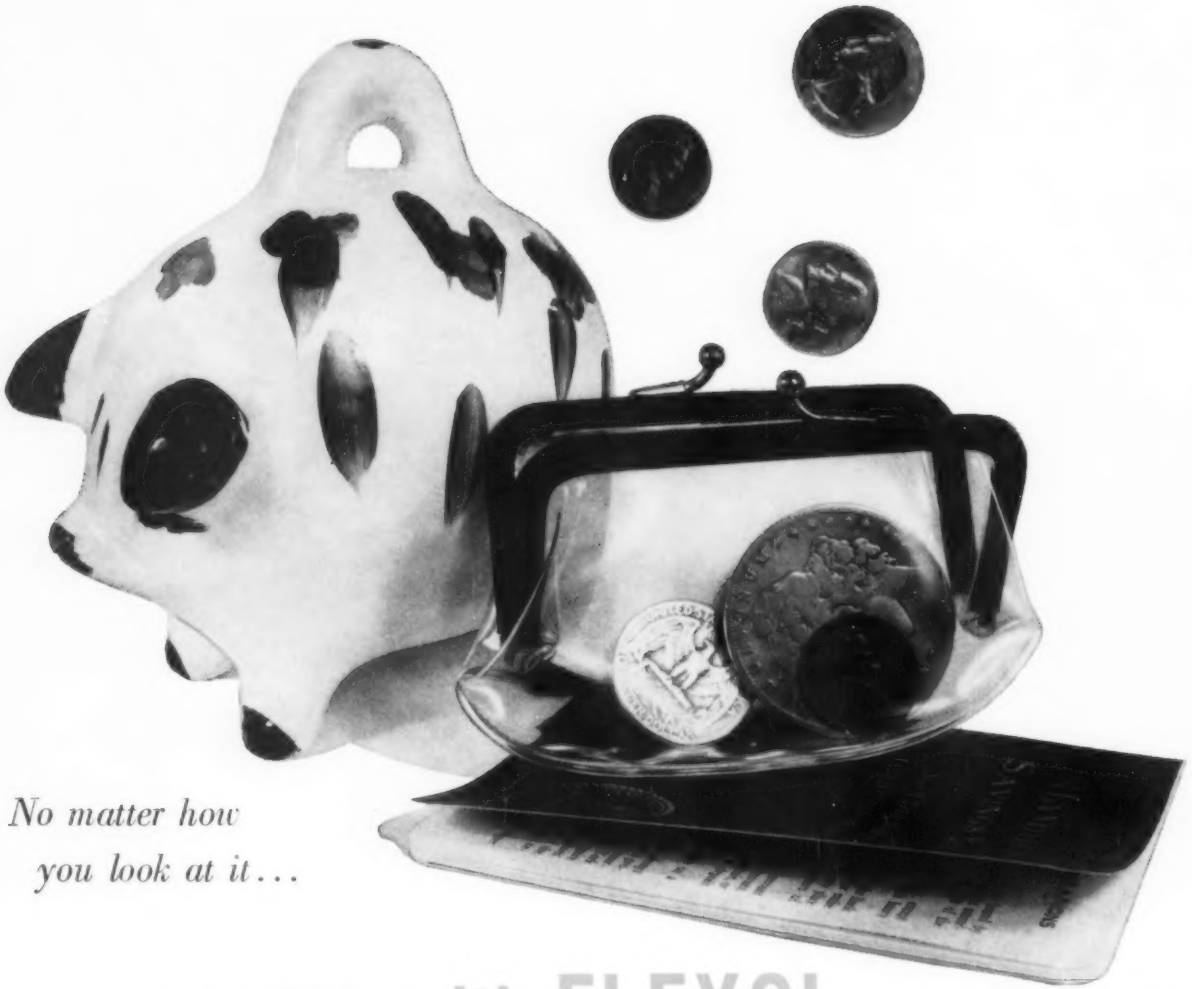

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Effects of Time, Temperature, and Environment on the

Mechanical Properties of POLYESTER-GLASS LAMINATES

by B. B. PUSEY* and R. H. CAREY*

The tensile, compressive, and flexural properties of six representative polyester-glass-fabric laminates have been determined over a temperature range from 23 to 100° C. It was found that increasing temperatures produced a reduction in compressive and flexural strength that was greater than the reduction in tensile strength. Increased temperatures erased the presence of an initial "proportional limit" in tension. Representative stress-strain curves are given for several temperatures; it is shown that strength is more affected by temperature than is modulus of elasticity.

Stress-rupture data for six resin-glass laminates are given which show the long-time strength to be considerably less than the strength as determined by short-time testing procedures, and also show that there is considerable difference between resins. Stress-rupture data in a water environment (stress-corrosion-rupture) show that the presence of water reduces the allowable long-time stress still further; there is a considerable difference between resins in this regard. For structural design purposes, the stress-corrosion-rupture stress at 1000 hr. is a more realistic value than the tensile strength. Data determined in this manner are useful in designing structures, such as pipe, that are subject to continuous stress in the presence of water.

FIBROUS glass-reinforced plastics were first designed into non-structural applications during World War II. At first these molded parts were small and simple and designs were based upon limited strength information. After the close of World War II, reinforced plastics began to capture the imagination of industrial engineers. The combination of low-pressure resins and fibrous glass mats and fabrics widened the field of geometric shapes that could be produced at a minimum cost. The structural engineer and naval architect began to design large shapes of complex curvature. The glass industry developed a wider variety of materials for plastic laminating. The chemical industry developed resins and resin-glass interface reagents to meet higher performance needs.

Design engineers have been presented with lists of standard, room temperature, mechanical properties with which to design structural components. They have been obliged to select large factors of safety based upon these mechanical properties and field experience. The effects of time, temperature, and environment, however, upon design strengths are not represented by short-time tests. The introduction of reinforced plastics into structural design is presently being retarded by a lack of significant measures of structural strength. There are few data on reinforced plastics to which the design engineer can apply the concept of anticipated service life.

The purpose of this paper is to present some experiences in the evaluation of low-pressure laminating resins for structural applications. Emphasis is placed upon one type of test that has proved to be very effective for evaluating resins, reinforcements, and resin-reinforcement interface reagents. In this work an attempt is made to integrate the factors of time, temperature, and environment upon the mechanical strength of six reinforced plastic laminates. It is believed that data such as these given here will contribute to the effectiveness of design and stimulate the development of resins and reinforcements.

*Development Laboratories, Bakelite Co., Div. of Union Carbide and Carbon Corp.

Materials and Procedures

The six laminates studied in this report were based on standard Bakelite polyester resins. These resins are listed below with the reasons for their selection:

1) BRS-147. A rigid resin approved under Military Specification MIL-R-7575.

2) BRS-193. A rigid resin also approved under Military Specification MIL-R-7575.

3) BRS-264. A representative semi-rigid resin.

4) BRS-193/BRS-136 (90/10). A representative mixture of a rigid resin and a flexible resin.

5) BRS-193/styrene (88.5/11.5). A representative mixture of a rigid resin and monomeric styrene.

6) BRS-193/BRS-264 (80-20). A representative mixture of a rigid resin and a semi-rigid resin.

All laminates were reinforced with 12 plies of 181-136 glass fabric(1).[1] The 181 glass fabric is an 8-harness satin-type weave. The 136[2] is a silicone finish applied to the glass fabric to improve adhesion between the glass and the resin. Resins were applied to the fabric by the pour-on method. Laminates were cured for 25 min. at 54 to 60° C., followed by 30 min. at 115 to 125° C. All were molded to stops.

Test specimens were wet-cut from laminates using a Felker Di-Met circular saw blade. Critical edges were finished using a carbide-tipped milling cutter. Test specimens were conditioned in air at 23° C. and 50%

[1]Numbers in parentheses link to references at end of article, p. 229.
[2]Owens-Corning Fiberglas Corp. designation.

Fig. 1—Six-position apparatus for flexural stress-rupture testing of laminates

relative humidity for 7 days before testing. All tests were made with the stress axis parallel with the warp direction of the fabric.

Short-time mechanical properties of these laminates were determined in accordance with standard testing procedures (2, 3, 4).

Flexural stress-rupture testing was done using the six-position tester shown in Fig. 1. This apparatus permitted the application of constant flexural stresses for long periods of time. Tests were conducted in air and in liquid environments at room and at elevated temperatures. Loads were applied without shock to the test specimens. Simultaneously, an electric timer was started for each specimen which stopped automatically when the specimen ruptured. Stresses that caused failure in from 1 to 1000 hr. were applied. This test was applied to the six laminates, in air and in water, at 23, 40, and 60° F.

Tensile stress-rupture tests were conducted on the three principal laminates in water at 23 and 60° C.

Standard Mechanical Properties

An engineering description of materials must include mechanical properties as defined by familiar methods of evaluation. Without such parameters as tensile, compressive, and flexural strengths, moduli of elasticity, and density, the engineer cannot classify new structural materials.

Stress-strain curves in tension, compression, and flexure are presented for the laminate made with Bakelite BRS-193 resin, which exhibited average mechanical properties for this series. These data, measured over a temperature range of 23 to 100° C., are shown in Fig. 2. The tensile strength of this laminate is not greatly reduced by increasing temperature. The compressive strength is moderately reduced, and the flexural strength is greatly reduced.[3]

Although the moduli of elasticity in tension, compression, and flexure are reduced by elevated temperatures, the reduction in rigidity is not as great as the reduction in strength. Thus, a strength measurement would appear to be a more sensitive indication of the properties of a laminate than a rigidity measurement.

Two tensile moduli of elasticity are found when 181 glass fabric is used as reinforcement. The BRS-193 laminate (Fig. 2) exhibited a tensile modulus of 3.2×10^6 p.s.i. up to a stress of about 5000 p.s.i., then the modulus decreased abruptly to 2.6×10^6 p.s.i. A distinct point of inflection exists at about 5000 p.s.i. at 25° C., but disappears with increasing test temperatures. If a specimen is prestressed above this point of inflection, a subsequent reloading of the same specimen produces a stress-strain curve that does not have an inflection point. The secondary modulus (the lower value) should be used for design purposes. Flexural[4] and compressive stress-strain curves do not show a point of inflection.

These materials are not ductile. Figure 2 shows the elongation at break to be about 1.5%, and independent of temperature over the range investigated.

The curves of Fig. 3, p. 142, give standard strength and elasticity measurements as a function of temperature for laminates made with the six polyester resins. These suggest that the standard mechanical properties of laminates made using BRS-147 are least reduced at elevated temperatures, those using BRS-193

[3]The flexural strength of a polyester-glass laminate, in fact any material, is a complex property since flexure is a combination of the fundamental stresses, tension, compression, and shear. Since the flexural and compressive strengths of these materials are significantly temperature-dependent while the tensile strengths are not, it may be concluded that these materials fail primarily because of compression when they are loaded in flexure.

[4]Flexural strain was calculated from the relationships for maximum stress and modulus of elasticity in simple beam bending.

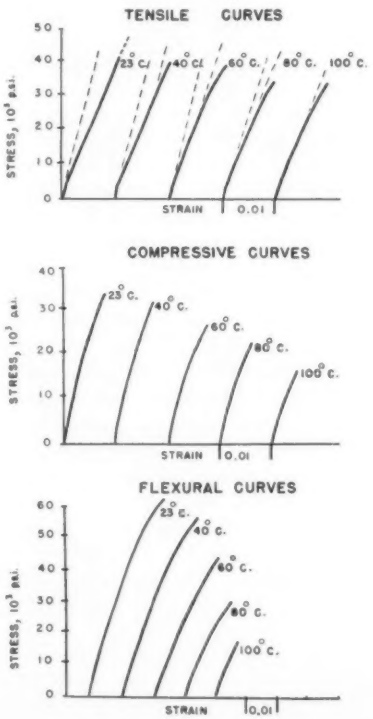

Fig. 2—Stress-strain curves for a polyester (Bakelite BRS-193)-glass fabric (181-136) laminate

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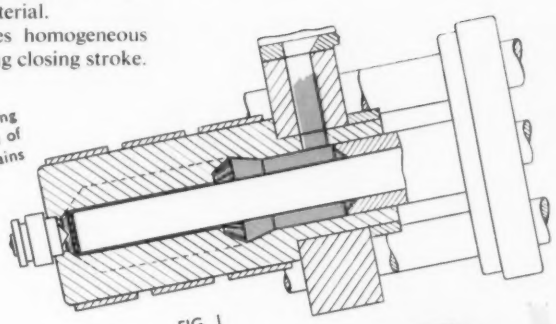

FIG. 1

Fig. 1.—FORWARD POSITION. Here the prefilling ring has drawn back clear of the feed and a fresh charge of material passes into the cylinder; the plunger remains forward.

Fig. 2.—BACK POSITION. After the new charge has been drawn in, the prefilling ring travels forward, compressing the material at the same time as the plunger moves back ready for its forward injection stroke. The nozzle is designed to restrict the escape of material during this action.

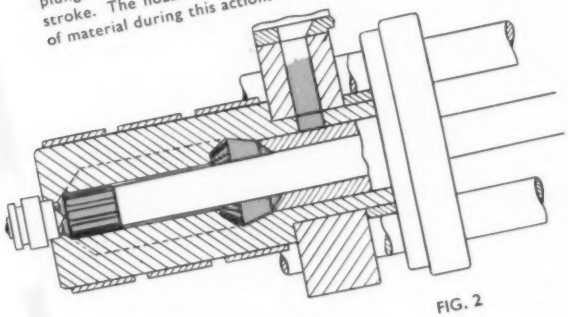

FIG. 2

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Total pressure on Injection plunger	18,850 lb.
Mold opens (adjustable)	6—9 in.
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Minimum die space	3½ in.
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Size of die plates	16 x 10 in.

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are reduced to a greater degree, and those using BRS-264 are markedly reduced. The properties of the resin mixtures greatly resemble the BRS-193 alone.

Long-Time Strength

The great majority of strength data, published for plastic materials, expresses the ability to support a stress that is brought to a maximum in from 1 to 2 min. in air at 23° C. Such tests are useful in providing an initial idea of the "strength" of a material. However, these tests do not reproduce many conditions of use and may give a misleading estimate of strength. For example, a pipe conveying hot water under pressure is subjected to three factors that the standard tests do not reproduce, namely, the sustained nature of the stress, the action of the water on the stressed material, and the elevated temperature.

The preceding paragraphs discussed the effect of temperature on the short-time mechanical properties of six polyester-glass laminates. The following discussion will describe the effects of water and temperature on the long-time strengths of these six laminates. Under prolonged deadweight stressing, many materials fracture or break when stressed at values considerably below their short-time strengths. Tests that are designed to bring out this phenomenon are known as stress-rupture tests. Where these tests are applied to materials in the presence of water or other environments, failure may occur in a relatively short time, showing the effect of the environment upon the stressed material. Tests that are designed to evaluate the effect of environment on stressed material are called stress-corrosion-rupture tests. The information from these tests is directly applicable to many engineering problems.

The effects of time, temperature, and environment on the flexural strength of these laminates are represented in Fig. 4, where flexural stress is plotted against log of time to failure. It is evident from these data that the flexural strength of all laminates investigated were reduced by the following: 1) increased time under stress, 2) increased temperature of test, and 3) presence of a water environment.

Increased Time Under Stress—All curves representing the six laminates studied showed a decrease in rupture stress with an increase of time under stress. Laminates bonded with BRS-264 were more sensitive to long-time stressing than laminates bonded with BRS-147. This was true in all environments tested. It is generally believed that these lines curve and become parallel to the time axis. While the data reported here do not

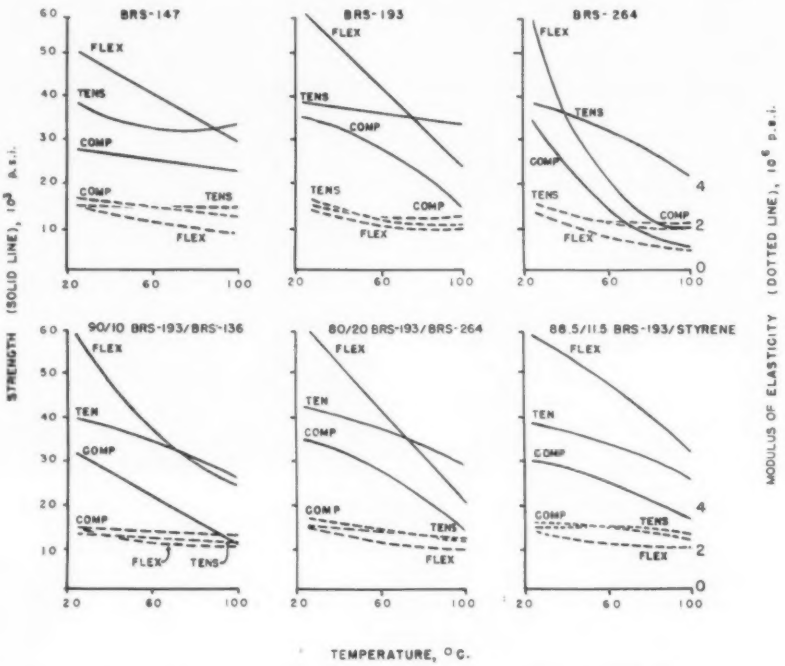

Fig. 3—Short-time mechanical properties of six polyester-glass fabric laminates

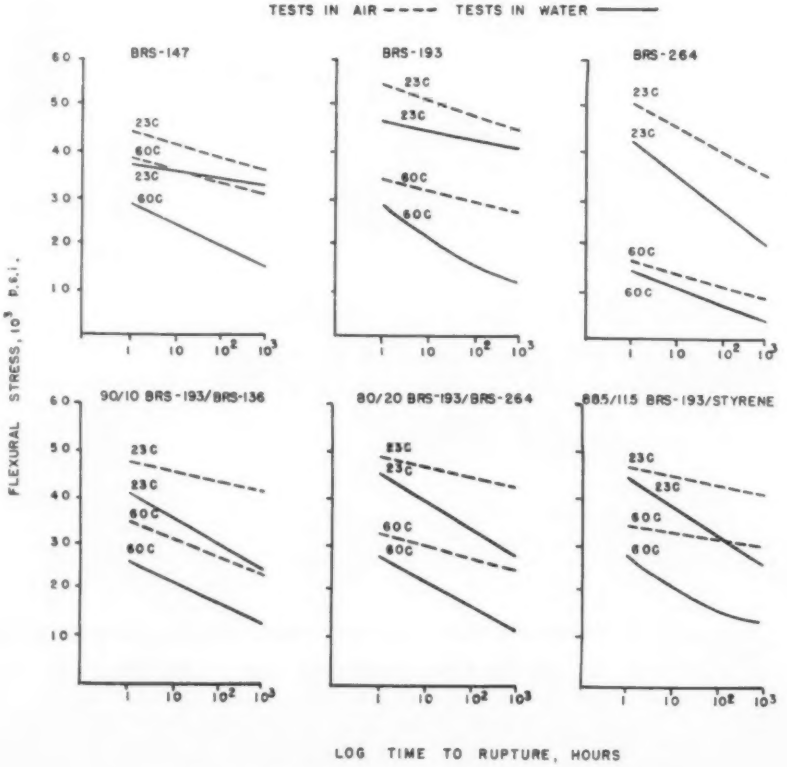

Fig. 4—Flexural stress rupture for six polyester-glass fabric laminates

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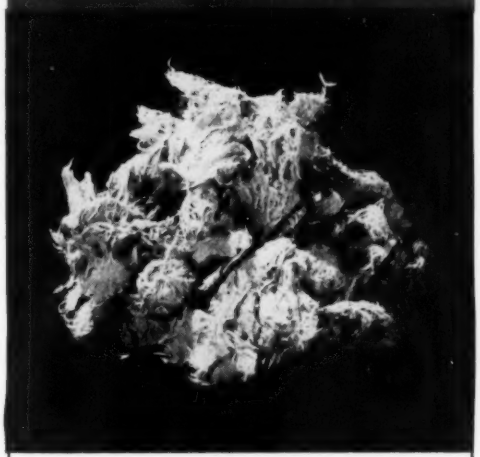

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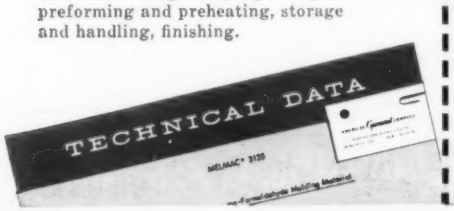

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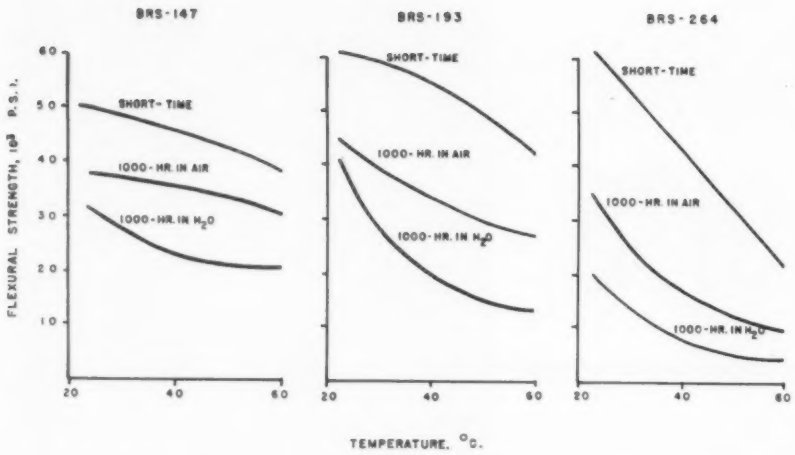

Fig. 5—1000-hr. flexural strengths for three polyester-glass fabric laminates

confirm this opinion, neither do they deny it; there probably is some stress which will be carried indefinitely without rupture, at least for all practical periods of time.

Increased Temperature of Test—As the temperature of test increased, stress-time curves were depressed vertically. The BRS-147 laminate supported about 5000 p.s.i. less in air at 60° C. than it did in air at 23° C., while the BRS-264 laminate supported about 30,000 p.s.i. less for the same increase in air temperature. Results from the standard flexural tests qualitatively confirmed this temperature sensitivity.

Presence of a Water Environment—Stress-time curves determined in water were lower than stress-time curves determined in air. This reduction in strength represents the effect of a water environment on the stressed material. For a period under stress of 1000 hr., the BRS-147 lost 5000 p.s.i. in an environment of water at 23° C., while the BRS-264 lost about 12,000 p.s.i.

The greatest stress that a material can support for 1000 hr. is frequently used to compare the design strengths of structural materials. Although this measure of strength yields a value that is a function of time, temperature, and environment, it must be borne in mind that most structures are designed to last more than 1000 hours. However, this test does give information that represents a convenient level for comparing structural materials.

Thousand-hour flexural strengths in air and water at 23 to 60° C., inclusive, are shown in Fig. 5 for the three principal resins. The standard flexural strengths are also shown. Here, the factors of stress, time, temperature, and environment are clearly illustrated. The slopes of all curves indicate the degree of temperature dependence of these strength measurements. The depression of the 1000-hr. flexural strength in air below the standard flexural strength in air indicates the effect of time on the stressed material. The vertical displacement of the 1000-hr. flexural strength in water below the 1000-hr. flexural strength in air isolates the effect of environment upon the material.

Plastic laminates generally exhibit resin-rich, glossy surfaces. It is believed that these surfaces retard penetration of liquids from environments and, in this way, protect structures from stress-corrosion failures. The specimens used in this work were prepared from laminates; therefore, edges were machined and the two surfaces were as molded. The effect of the machined surfaces on the flexural design strength in water was investigated by testing specimens ¼ to 1 in. wide. The 1000-hr. strength of the ¼-in. specimens was 9700 p.s.i., while the 1000-hr. strength of the 1-in. specimens was 10,200 p.s.i. This variation is within the panel-to-panel variation experienced in this testing. Several specimens were tested in water after coating the machined edges with a thick layer of stop-cock grease. The results from these "protected" specimens did not differ significantly from results obtained from uncoated specimens. Thus, it is believed that data determined from this work are applicable to larger areas of laminated structures.

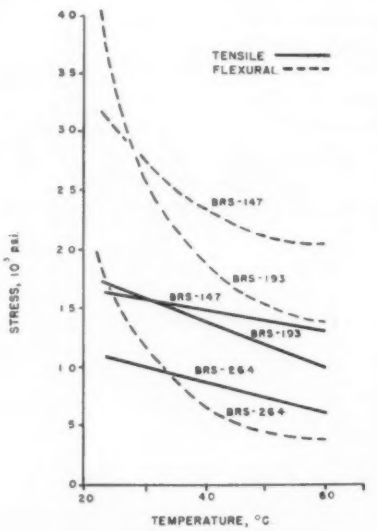

Fig. 6—1000-hr. tensile and flexural design stress for three polyester-glass fabric (181-136) laminates

Tensile Stress-Corrosion-Rupture

Tensile stress-corrosion-rupture tests were conducted on laminates bonded with the three primary resins. Thousand-hour tensile strengths were determined in water at 23 and 60° C. (Fig. 6).

The tensile and flexural stress-corrosion-rupture tests arrange the three laminates in the same order. The trend of tensile strength with temperature is the same as flexural strength with temperature, but the change with temperature is greater in flexure than in tension. This magnification of design stress-temperature trends makes the flexural stress-corrosion-rupture test a more sensitive tool for resin development work. After a material has shown promise on the flexural test, its design tensile, compressive, shear, and bearing stresses may be determined.

Conclusions

Short-time mechanical properties, determined in air at room temperature, are of limited value to the design engineer. The same properties, determined over a temperature range, although of more value, are still of limited usefulness.

Results from standard mechanical tests performed in corrosive environments do not necessarily measure

(*To page* 229)

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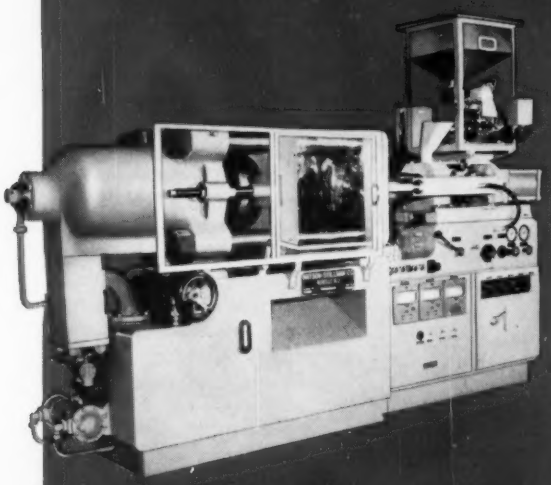

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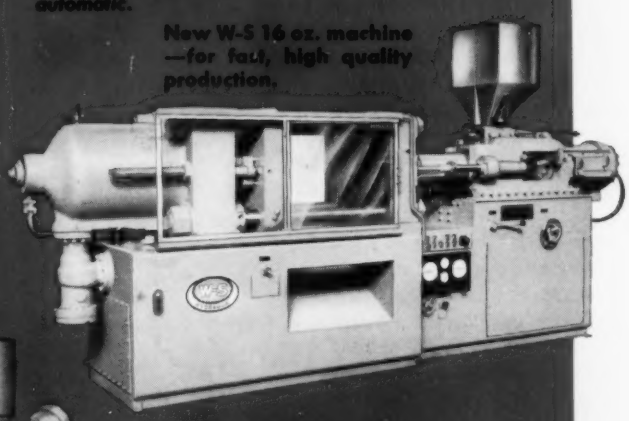

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Moments of Inertia and Deflection of

Plastic Sandwich Beams

by MELVIN MARK*

IN AIRBORNE radar systems the designer is very much concerned with the structural characteristics of the radome. A common radome material is the plastic sandwich-type structure composed of two faces or skins of dense material and equal thickness, separated by and bonded to a low-density core such as fibrous glass honeycomb. It has the advantage of a high strength-weight ratio so important in aircraft structures. The employment of this type of construction in search radar is representative of its many applications. The problem arises of how to calculate the moment of inertia for a sandwich beam construction and what to use for the associated flexural modulus of elasticity. A first approximation would be to assume that only the skins contribute to the moment of inertia, that they are held apart a distance equal to the core thickness, and that they develop their full modulus of elasticity. To check this simplified analysis four sample sandwich materials with different skin and core thicknesses were tested as beams and their deflections measured under load. Comparison could then be made with the load-deflection ratio calculated as described.[1]

The four sample beams were of constant cross section, simply supported, 30 in. between supports, with a concentrated load applied at the center of the span. Beam width was 5 in.; skin and core thicknesses were as given in Table I. The skin material was made of polyester resin (Selectron 5003) with 181 and 113 glass cloth of 114 finish. (The finer 113 glass cloth was used to obtain a smooth sandwich surface.) The core was ¼-in. cell size fibrous glass honeycomb with a density of approximately 8 lb./cu. foot. All samples were cured at room temperature. A flexural modulus of elasticity of 3.4×10^6 p.s.i. (obtained by measurement) was used for the skin material, and isotropy was assumed.

Neglecting the core, the moment of inertia of the cross section of the sample beam (see Fig. 1), can be calculated from the equation:

$$I = 2\left(\frac{bt^3}{12}\right) + 2bt\left(\frac{c+t}{2}\right)^2 \qquad \text{Eq. 1}$$

where b is the width of the beam, t the skin thickness, and c the core thickness. If $t < \frac{1}{6}c$, this reduces (with an error of less than 3%) to

$$I = btc\left(t+\frac{c}{2}\right) \qquad \text{Eq. 2}$$

The deflection at mid-span for a simple beam loaded as described and neglecting shear ($c+2t \ll l$) is:

$$d = \frac{Wl^3}{48EI} \qquad \text{Eq. 3}$$

where d is the deflection, W the concentrated load, l the span length, E the modulus of elasticity (of the skin material in this case), and I is the moment of inertia, units of pounds and inches being used.

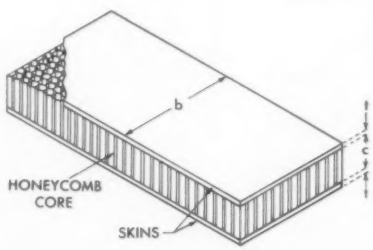


Fig. 1—Diagram of plastic sandwich-type beam; *b* is width of beam, *t* is skin thickness, and *c* is core thickness

Substituting Eq. 2 in Eq. 3:

$$d = \frac{Wl^3}{48E\,btc\left(t+\frac{c}{2}\right)} \qquad \text{Eq. 4}$$

or:

$$\frac{W}{d} = \frac{48Ebtc}{l^3}\left(t+\frac{c}{2}\right) \qquad \text{Eq. 5}$$

From equation 5 the load-deflection ratios were calculated.

For each sample beam mid-span deflections were measured with a dial indicator over a range of loads from 3 to 30 pounds. A plot of load versus deflection could then be made and the slope (load-deflection ratio) determined for each sample. These plots were linear for all samples with data scatter less than 5 percent (see Table I).

It can be seen from Table I that the simplified approach of calculating the moment of inertia for a plastic sandwich beam by neglecting the core and assuming the skins develop their full modulus of elasticity gives answers that are within 10% of the measured results. A more comprehensive analysis of sandwich-type beams is given by Dietz,[2] and his equations can be reduced to equations 2 and 5 for the conditions described. This simplified analysis should be applicable to all long sandwich-type beams in bending where the skin thickness is small compared to the thickness of the core and where the core is sufficiently strong in shear to prevent collapsing of the two skins. Extension of this type of approximation to plates and shells could be made by substitution of the expression equivalent to the stiffness factor EI, as calculated here, into proper plate and shell equations.

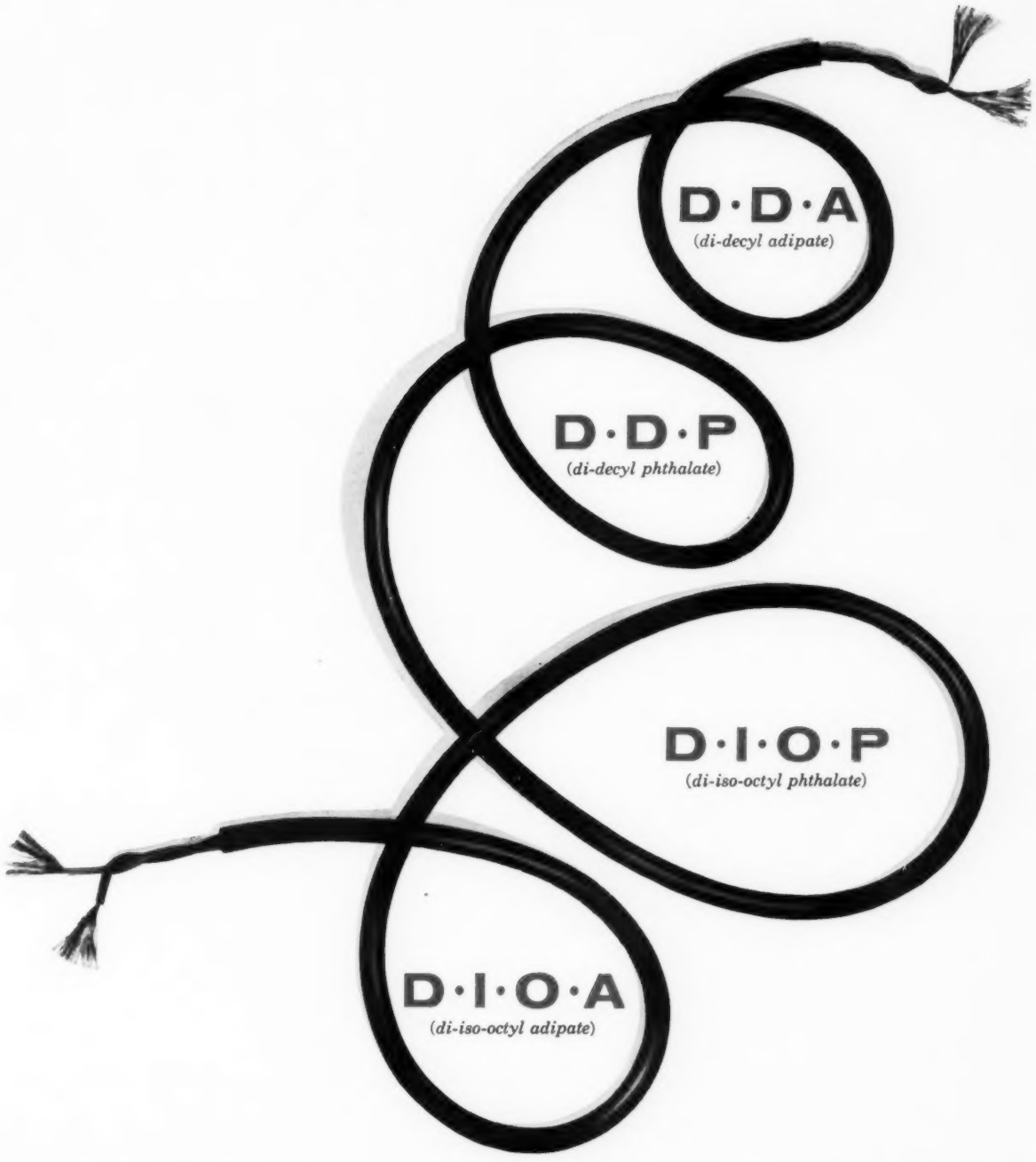
Table I—Load-Deflection Ratios for Sandwich-Type Plastic Beams

Sample	Thickness, in.		Mid-span Load-Deflection Ratio, lb./in.	
	Core	Skin	Measured	Calculated
I	0.204	0.029	21.8	23.4
II	0.228	0.022	20.5	20.6
III	0.275	0.014	17.4	17.5
IV	0.180	0.029	19.6	18.0

* Radar and Communication Div., Raytheon Mfg. Co., Newton, Mass.

[1] This work was done under Convair's B-58 program at Raytheon Mfg. Co.

[2] A. G. H. Dietz, *"Engineering Laminates,"* John Wiley and Sons, Inc., New York, 1949, pp. 60-63.



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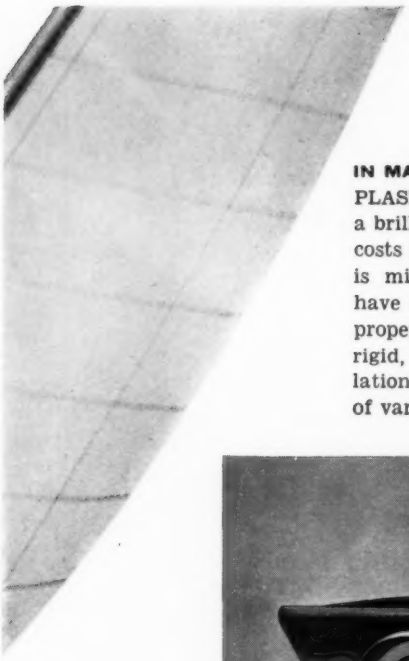

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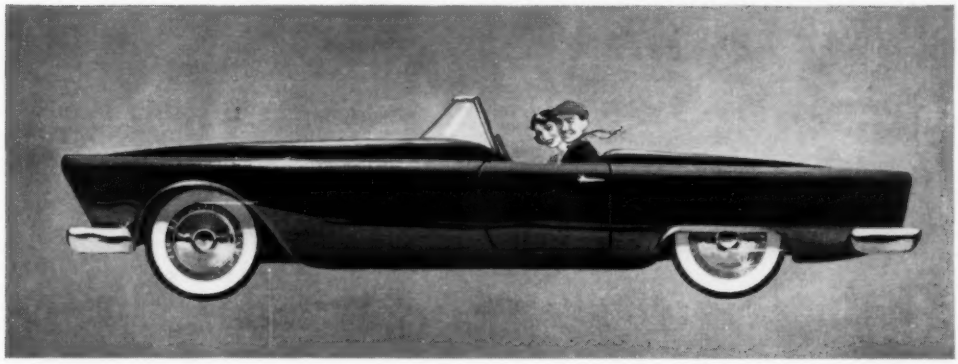

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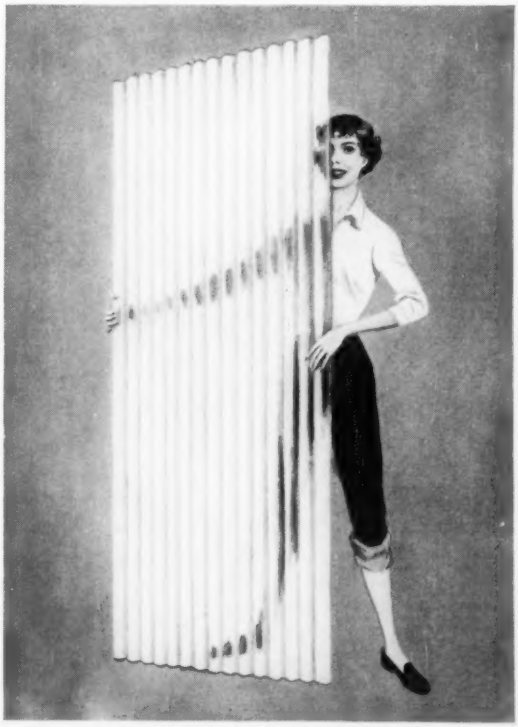

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Parallel Glass Fiber-Reinforced Plastics

by JAMES W. CASE* and J. D. ROBINSON**

THE objective of this investigation was to utilize the physical qualities of fine glass fibers in a composite glass-plastic laminate, or in end products made of this material. The work on parallel glass fibers has been concerned generally with adhesive relationships between glass fibers and resins. As a result, flexural strengths have been of major importance in evaluating results and guiding the program. It is recognized that the soda glass used in producing the fibers is probably not the ideal material, but it is believed that benefits developed in this fiber system can be translated readily to other glass fiber systems.

The L/D curves of parallel glass fiber laminates, in contrast to those made of woven fabric, are long, straight lines with their points of departure (elastic limits) very near the rupture points (Figs. 1 and 2). Table I further brings out the actual relative strength values between parallel and woven glass laminates.

Figure 3 shows that the change of flexural strength values with variations in span-depth ratios is rapid in the portion of the curve between a ratio of 8/1 and 18/1 for the parallel glass fiber laminate. At the ratio finally chosen for the test method, 24/1, the change is very slight as the ratio varies. It is probably significant that with improved adhesion of plastic to glass, the shear forces must be minimized in order to insure failure of the fibers in compression and tension. Shorter span samples (lower ratio) fail consistently in shear, while samples at 24/1 ratio fail in compression and tension, thereby giving higher test results. Apparently, the original 8/1 ratio of the ASTM system was changed to the present 16/1 ratio for similar reasons.

Effect of Surface Treatments

The chemical treatment of glass fibers to produce better adhesion to plastic by modification of the surface was investigated at some length. Forty-one treatments were applied to the fibers by creating an atmosphere of the material in the enclosed space at the bushing from which the hot fibers were drawn. The aerosol was created by spraying the chemical or solvent solution (usually acetone) against a baffle to produce turbulence and the hot zone maintained vaporization and evaporated the solvent. The treated fibers were collected in strips on a drum in controlled numbers by spinning for a designated time at fixed r.p.m. The strips of treated fibers were then wet with polyester resin and cast inside glass tubing into rods about 0.30 in. in diameter. No tension was necessary to establish a unidirectional pattern for there was no twist in the strips. The flexural strength and the compression strength (endwise) were determined for each set of rod samples as a measure of adhesion between glass and resin. Each rod had the same

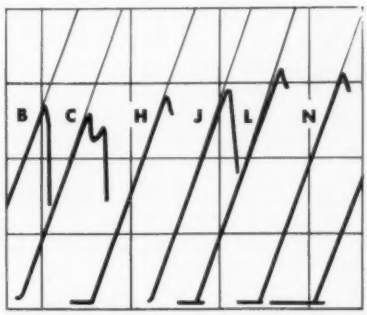

Fig. 1—Chart record of flexure test on parallel glass-polyester laminates

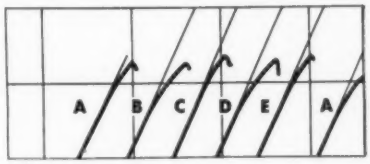

Fig. 2—Chart record of flexure test made on laminate of 181-114 glass cloth and polyester resins

Table I—Comparison of Flexural Strength of 181-114 Glass Cloth and Parallel Glass Laminates Made with Polyester Resins[a]

Sample	Ultimate flexural strength	Elastic limit	Flexural modulus of elasticity
	p.s.i.	p.s.i.	10^6 p.s.i.
	181-114 GLASS CLOTH		
A	47,700	26,400	2.39
B	46,200	24,100	2.40
C	49,300	30,500	2.66
D	49,200	22,900	2.63
E	50,900	30,400	2.57
—	54,400[b]	34,200[b]	2.8[b]
	PARALLEL GLASS (7 PLY AT 90°)		
B	101,800	97,000	—
C	97,600	89,000	—
H	105,500	101,000	3.36
J	107,300	85,000	3.47
L	119,000	94,000	3.59
N	115,500	99,000	3.36

[a] From Englander Co., Plastics Div., Baltimore, Md., Contract Nord—13462.
[b] From data by Forest Products Laboratory, Madison, Wisc.

* Navy Bureau of Ordnance, Research and Development Div., Washington, D. C.
** Firestone Tire & Rubber Co., Akron, Ohio

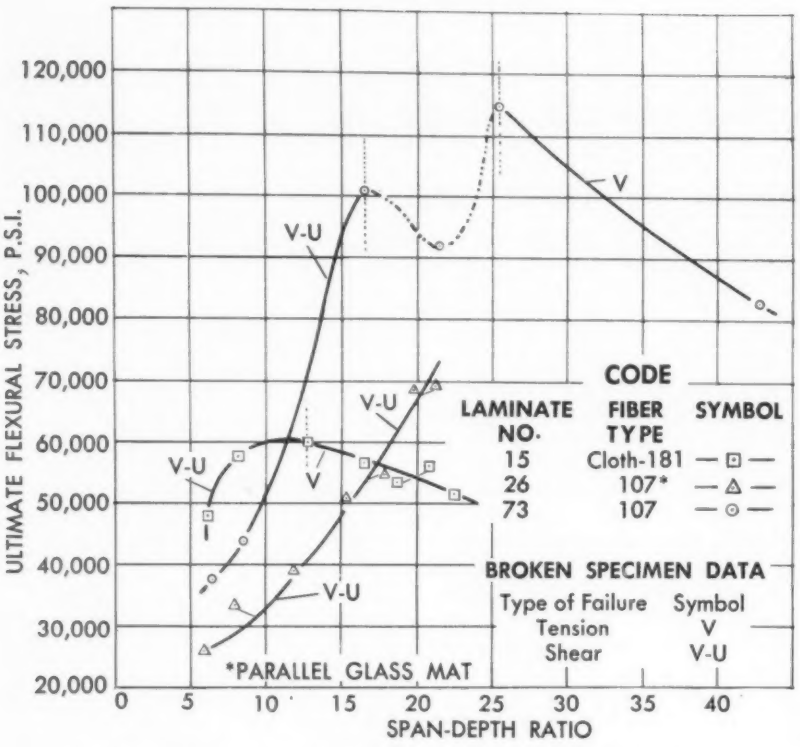

Fig. 3—Variations in flexural strength with variations in span-depth ratios

number of fibers (96,000) and, as an indirect measure of fiber diameter, had essentially the same glass content by weight.

None of the chemicals tested (Table II) gave an important increase in strength to indicate improved adhesion. Certain phenolic resins gave an increase of about 25% in strength. At the same time, no imporant decrease in strength was observed when materials expected to be harmful were used.

Wet Strength

Work on wet strength retention of parallel glass fiber laminates has been subordinated to other phases of the program on the basis that the results of the extensive research of fiber treatment for wet strength retention elsewhere could be translated to the parallel glass fiber system at the proper time. Preliminary results show that parallel glass fiber laminates prepared with polyester resins have flexural strengths of 82,000 p.s.i. wet and 123,000 p.s.i. dry with less than ±5% variation in the dry strength obtained. While the percentage loss in strength when wet is larger than that reported lost with certain fiber treatments, it should be noted that the absolute wet strength is high compared to the wet strength of conventional structures. The wet materials also have high elastic limits.

An attempt to improve wet strength retention by using binders designed to have "tighter" cure was not successful. By the use of phenolic-epoxy resin combinations it is possible to maintain modulus (stiffness) and eliminate the flexibility usually found in laminate samples after boiling. But all the resin binders tested appeared to be affected by water and to develop the slimy substances seen when resin castings are boiled; these act as lubricants and reduce the strength by loss of adhesion.

In collaboration with members of the staff of the Naval Ordnance Laboratory, some of the silicone finishes developed in their work were applied to the parallel glass fibers after they were collected on the drum. The application technique left much to be desired and difficulties were encountered in hydrolysis and washing the modified chlorosilane treatment. However, laminates from the NOL treated fibers show flexural strengths about 79,000 p.s.i. wet and 86,000 p.s.i. dry. Further work might improve these preliminary results to an acceptable level.

During the preparation of chemically treated fibers, a parallel glass fiber mat was produced from fibers that had been sprayed with the silicone emulsion, Linde GS-1. A laminate from the fibers showed fair

Table II—Chemical Treatments Applied to Glass Fibers

1. Water
2. DC 200 in chloroform
3. Sulfur dioxide
4. Chloroform
5. Styrene
6. Pyridine
7. Diethylene triamine
8. Alpha-terpineol
9. DC 200-HCl
10. Hydrochloric acid
11. Hydrofluorosilicic acid
12. Morpholine
13. Sulfuric acid
14. Alpha-terpineol
15. Selectron 5003
16. S9 (epoxy resin)
17. Silicone (Linde GS-1)
18. Dicyclopentadiene resin (RBH 569)
19. Diallyl phthalate prepolymer, 85/50
20. Phenolic (Bakelite BV 17085)
21. Melamine-formaldehyde (Melmac 405S)
22. Volan (chrome-acrylic complex)
23. Dehydrocastor alkyd (Syntex No. 9)
24. Propylene glycol maleate (UCC)
25. Trimethyl nonyl alcohol
26. Benzoguanamine-formaldehyde (PDL1-1178)
27. Phenolic (GE 12304)
28. Epichlorohydrin
29. Parlon
30. Rubber-phenolic (GE 12359)
31. Epon 1001 (PAA)
32. Phenolic (Bakelite BR 17913)
33. Phenolic (Bakelite BV 9700)
34. Phenolic (Bakelite BV 1112)
35. Phenolic (Bakelite BRQ 18689)
36. Phenolic (Bakelite Saligenin)
37. Phenolic (Bakelite BR 200)
38. Phenolic (Bakelite BR 200, BR 18774)
39. Phenolic (Bakelite BR 15401)
40. Phenolic (Bakelite BRQ 17917)
41. Phenolic (Bakelite HF 1772)

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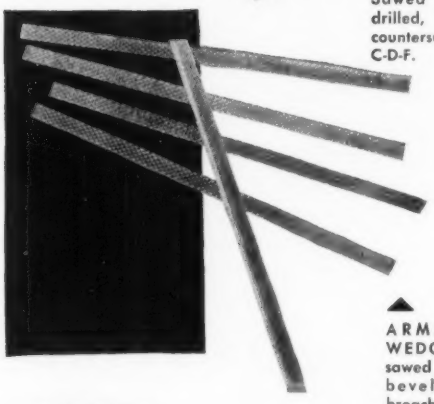
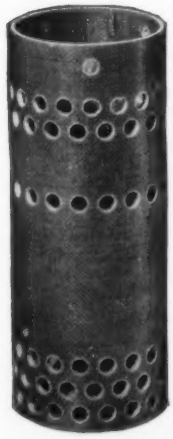
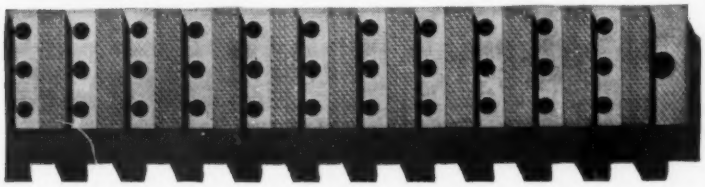


ARMATURE SLOT WEDGES — GB-28M, sawed into strips, then beveled edges were broached to angle of 21° 23', and strips were cut to exact length. Machined by C-D-F.



RF COIL FORM — Natural GB-112M Dilecto rolled tubing, smooth edged. Sawed to length; drilled and burred by C-D-F.

TERMINAL BLOCK—GB-28M. Sawed to shape, grooves milled, corners sanded round. Holes were drilled, counterbored, characters stamped. Machined by C-D-F.



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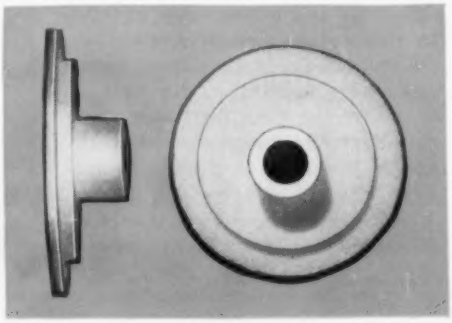

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Fig. 4—Pilot-plant production of uniform-weight parallel glass fiber mat

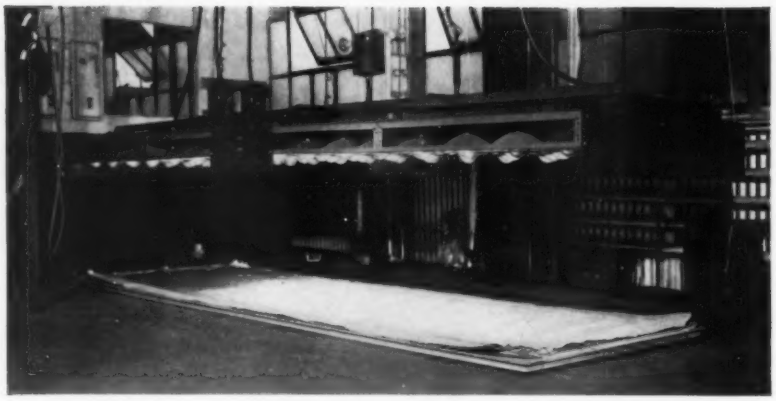

Fig. 5—Parallel glass mat impregnated with binder is cured under a horizontal bank of infra-red lamps, with the mat resting on a flooring of plywood

wet strength retention (60,000 p.s.i.). Another laminate was prepared in which VRS (vinyl triethoxysilane) addition to the laminating resin was used[1] and the wet strength retention was fairly high (61,000 p.s.i.). A combination of the two silicone treatments resulted in the laminate with wet strength of 82,000 p.s.i. and 123,000 p.s.i., dry. Linde GS-1 in solvents does not produce the same effect as the emulsion, emphasizing the importance of water in silicone treatments.

Production of Fiber Mats

Although the fiber-forming equipment is not ideal for a production facility, it is possible to produce uniform material on a pilot plant basis (Fig. 4). The production unit is a mat of parallel fibers 3 by 13 ft. in area and is specified in pounds per mat. Thus, a 4-lb. mat is 1.64 oz. per sq. ft. on the basis of commercial random mat specifications. Mats can be produced and shipped with weights varying between 1.0 lb. (0.41 oz./sq. ft.) and 10 lb. (4.1 oz./sq. ft.) or greater. The mats are uniform in weight per square foot across the area to less than 5% and the variations are uniform from a heavy center section to a thinner edge section. By virtue of the method of collecting the fibers, the concentration of fibers is uniform throughout. By control of the rate of glass fiber formation (lb./min.), the diameter of the fibers can be controlled rather closely. After the position of the binder spray gun has been fixed and the air pressure maintained at a constant low value, the binder content can be controlled to a completely satisfactory degree. Mats can be rolled on 3- to 4-in. diameter paper tubes 3½ ft. long with the fibers forming a hoop around the tubes, and shipped with no apparent harm to the mats.

The binder on the mats is currently cured under a horizontal bank of infra-red lights with the mat resting on a floor of plywood (Fig. 5). The result is a light-colored mat which produces slightly stronger laminates.

The binders have been sprayed onto the fibers in an acetone solution. Obviously, this procedure poses problems in production. It has been found that emulsions of the binder resins can be sprayed on the fibers with comparable success. The dry strength of the laminates appears to be equal and the wet strength is no lower. The mats do not appear to wash in laminate preparation, although the effect of humidity in storage on this characteristic is being studied. No information is available yet on the behavior of the emulsion bonded fibers after wet strength retention treatments.

Applications of Parallel Fiber Glass Mat-Polyester Laminates

As part of a program on the fabrication of simple shapes other than flat test laminates, sandwich structures have been prepared (Fig. 6). The assembly has been made by bonding a thin skin laminate to the core and also by laying up the skin to bond to the core and cure in one

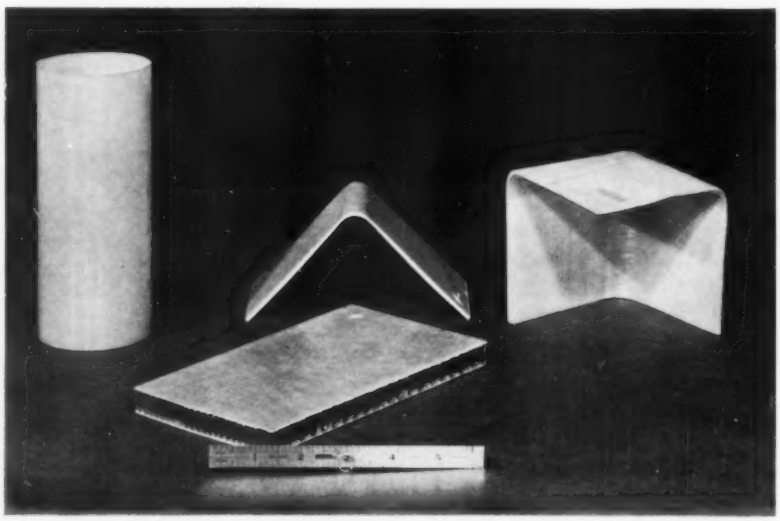

Fig. 6—Variety of shapes (cylinder, angle, corner, and sandwich) made with glass mat

[1] Plummer and Newmeyer, Preprints, 9th Tech. Conf. (1954), SPI Reinforced Plastics Div.; Sec. 28, p. 1.

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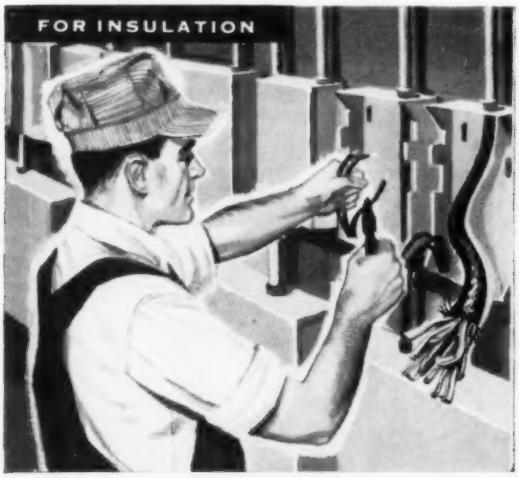

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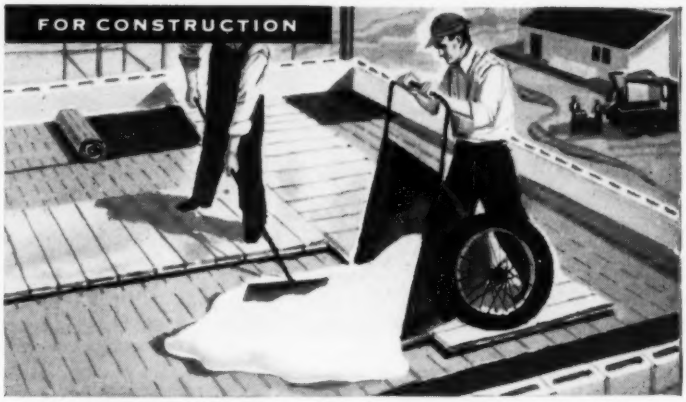

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Another interesting application of parallel glass fibers is in the field of body armor against flying fragments. Traditionally, this material is made with as poor an interlaminary bond as possible in order to insure delamination on impact of the fragment. It has been established that a conventional high strength parallel glass fiber laminate is effective in stopping fragments; application in this field is being investigated further. The possibilities of the parallel glass armor appear to be interesting in applications other than body armor; while conventional materials are effective as armor, they are weak structurally.

Fabrication of Shapes

There is a need for more knowledge on how to fabricate plastic shapes from parallel glass fibers. It is easy to visualize fabrication in shapes such as cylinders, cones, pyramids, etc., but the handling techniques have not been well developed. As a start in the work the following shapes have been produced on molds such as sheet metal and C-clamps provide:

1) Angles with ⅜ in. radius at the intersecting edge. They were made up with fibers at 0° and 90° to this edge as well as with fibers at 45° and 135° to the edge. The latter structure appeared to be stronger but both structures were produced without any apparent shifting of fiber pattern. Angles made from parallel glass fibers were compared with similar structures made with 181 glass cloth under impact of a falling weight (Fig. 7) and on the testing machine with slow load application (Fig. 8). The parallel glass fibers suffer much less damage on impact and require a substantially higher load to fail on the testing machine.

2) Corners with ½-in. radius on the edges of plane intersection (Fig. 6). The fabrication is similar to that used with cloth in that the corners are established by lapping tailored layers alternately. No strength values are available for the corners, but the structures appear to be sound and no unusual movement in the fiber pattern was observed at any time during the investigation of these corners.

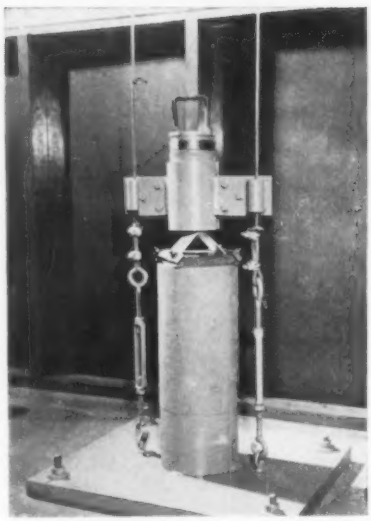

Fig. 7—Equipment used to test the effect of impact of falling weight on strength of angles made with parallel glass mat and with woven glass cloth

3) Contoured shapes involving some double curvature. The movement of the fiber pattern that must follow in such molding is averaged, and to some extent compensated for, by the use of fairly thin mats (1.5 and 2.0 lb.). The strength of these structures is now being thoroughly investigated.

Evaluation of Cylinders

Cylinders have been chosen as the shape best suited for detailed evaluation of parallel glass fiber reinforcement in practical use. One fabricating shop has found preimpregnated parallel glass fiber tape to be advantageous. The activity at Firestone is more conventional and consists of forming cylinders on a mandrel with the fibers saturated with resin as the cylinder is formed. Except for the relatively short lengths of mat available, parallel glass fiber mats handle much the same as woven glass cloth in the fabrication of reinforced plastics cylindrical shapes.

The glass fiber pattern used in cylinders has been varied rather widely. Hoop fibers of various mat densities have been combined with beam fibers of various mat densities in different proportions. Most of the fibers have been laid up at 0° and 90° to the axis of the mold, but cylinders have also been produced by winding parallel glass fiber tape alternately at different angles. The fibers asemble well on the 2.75-in. mandrel and wet well with resin. However, much remains to be learned about the techniques of handling the fibers. The mats are much more fragile than cloth but wet much more easily with resin and as a result require less manipulation during the impregnating process.

The average bursting strength of 12 cylinders produced with 2.75-in. inside diameter and 0.085-in. wall thickness was 1250 pounds. This represents a calculated tensile strength of 37,000 p.s.i. for the structure, of which the glass content is approximately 45 percent.

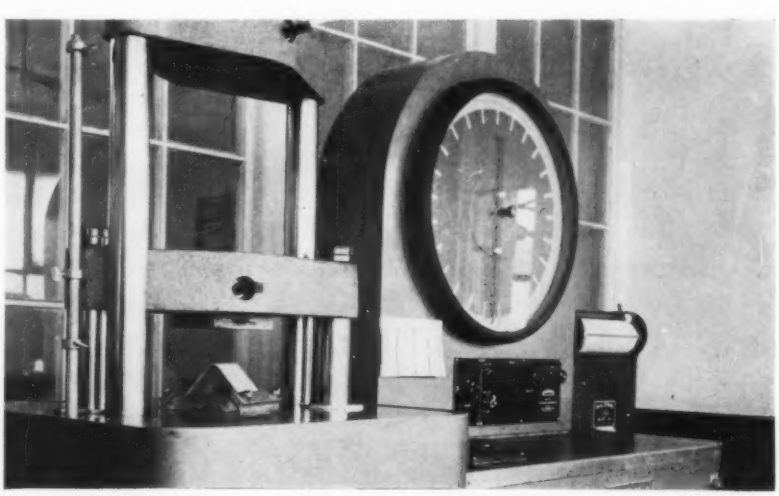

Fig. 8—Testing machine used to determine the effects of slow load applications on the strength of laminates made with parallel glass mat and with woven glass cloth

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PLASTICS DIGEST*

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General

INTERNATIONAL STANDARDS FOR INSULATION, MOTORS, COMPONENTS. Elec. Mfg. *54*, 126-35 (Nov. 1954). The results of the International Electrotechnical Commission 1954 meeting are summarized in special reports by U. S. delegates to key committees. Included are recommendations made by the International Electrotechnical Commission regarding motor dimensions, classification of insulating materials, and tests and ratings for electronic components. The proposed classification of electrical insulating materials is given.

Materials

STABILIZERS FOR VINYL POLYMERS. 1. SOAPS. H. V. Smith. Brit. Plastics *27*, 176-79 (May 1954). The choice of a stabilizer system for vinyl chloride polymers represents a compromise between the best solutions of five problems: heat stabilization efficiency in relation to process conditions; light stability in relation to the service expected of the product; the toxicity of the stabilizer; interaction between the stabilizer and other compounding ingredients; and physical form of the stabilizer. The three major forms of vinyl stabilizers are the metallic, the organo-metallic, and the organic. The bulk of vinyl resin formulations is stabilized by the addition to the polymer of small percentages of the so-called "soaps" or salts of metals with fatty acids. Theoretically, there is no reason why all the metals of groups I, II, III, and IV of the periodic system should not be used, but in practice the choice is restricted, mainly on economic grounds, to the following: I—lithium and sodium; IIa—magnesium, calcium, strontium, and barium; IIb—zinc and cadmium; IVb—tin and lead. The properties of soaps of these elements are discussed.

STABILIZERS FOR VINYL POLYMERS. 2. METALLIC COMPOUNDS OTHER THAN SOAPS. 3. THE ORGANO-METALLIC COMPOUNDS. H. V. Smith. Brit. Plastics *27*, 213-17 (June 1954). The following metal compounds are discussed as vinyl stabilizers: inorganic compounds—phosphates and phosphites, per-salts, silicates, and salts of the acids of sulphur; organic metal compounds—salts of organic acids, miscellaneous metal derivatives. Organo-metallic compounds discussed include organotin carboxylic acid salts, hydrocarbon tin alcoholates, polymeric organotins, sulphur-containing organotins, organotin sulphonamides, and miscellaneous organotins.

STABILIZERS FOR VINYL POLYMERS. 4. METALLIC COMPOUNDS OTHER THAN SOAPS. H. V. Smith, Brit. Plastics *27*, 307-311 (Aug. 1954). The purely organic stabilizers are discussed. These include urea derivatives; other amines, imines and imides; polymeric amine-type stabilizers; epoxide stabilizers; epoxide plasticizers-stabilizers; phosphites; esters; and various miscellaneous organic stabilizers. The properties are discussed and proprietary brands listed.

ISOCYANATE ELASTOMERS. E. G. Curphey. Brit. Plastics *27*, 407-09 (Oct. 1954). The composition and structure of polyester isocyanate elastomers are discussed and the effects of variations in the properties of the polyesters on the isocyanate-modified product are presented. Isocyanate-modified polyesters having terminal isocyanate groups lend themselves to further reactions with appropriate bi- and tri-functional compounds, such as water, polyamines, glycols, polyhydric alcohols, and organic acids, thus establishing further interlinks. The choice of interlinking agent is important and examples are given of the effects of various agents on the properties of the elastomer.

THE FUTURE OF POLYTHENE. J. C. Swallow. Brit. Plastics *27*, 364-65 (Sept. 1954). Uses of polyethylene can be classified broadly as: cables; film for packaging; solid moldings, such as containers; and extruded sections, such as tubing. The properties of the various grades of polyethylene vary widely and the different grades cannot be characterized by any one physical property. It is necessary to consider all of the properties in selecting a given grade for a given use. Research is now underway toward better control of the production process, to obtain polyethylene with a wide range of properties, and toward reduction of the cost of production.

SHELF LIFE IN POLYETHYLENE. J. Pinsky, A. R. Nielsen, and J. H. Parliman. Modern Packaging *28*, 145-55, 216, 218 (Oct. 1954). The results are presented of a long-term study of 67 chemicals in polyethylene bottles with data on permeability, chemical changes in the materials studied, physical changes in the polyethylene, and stress-corrosion cracking tendency of the polyethylene. Tests were conducted at 32 to 165° F. The permeabilities of polyethylene to the 67 chemicals are listed in tables, as well as the tensile properties, stress-corrosion activity, and concentration change and refractive index change of chemicals for conditioning periods of up to one year. The results indicate that polyethylene compares favorably with glass with regard to inertness and general packaging characteristics for many chemicals. The results also indicate that polyethylene can be employed with many more diverse materials than had previously been realized.

SCIENTIFIC SUCCESS STORY OF POLYETHYLENE TEREPHTHALATE. E. F. Izard. Chem. Eng. News *32*, 3724-28 (Sept. 20, 1954). The structure, synthesis, and properties of various polymers prepared during the development of the polyethylene terephthalates are discussed.

MOLDINGS FROM WOOD WASTE IMPREGNATED WITH THERMOSETTING RESINS. E. J. Ritter. Kunststoffe *44*, 329-32 (Aug.); 378-82 (Sept. 1954). The processing of wood waste molding compounds is described based on experiments made by the German Society for Molding Materials. The poor flow properties of the material must be considered in designing molds and the finished parts. The

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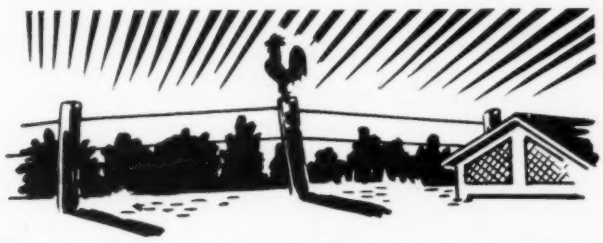

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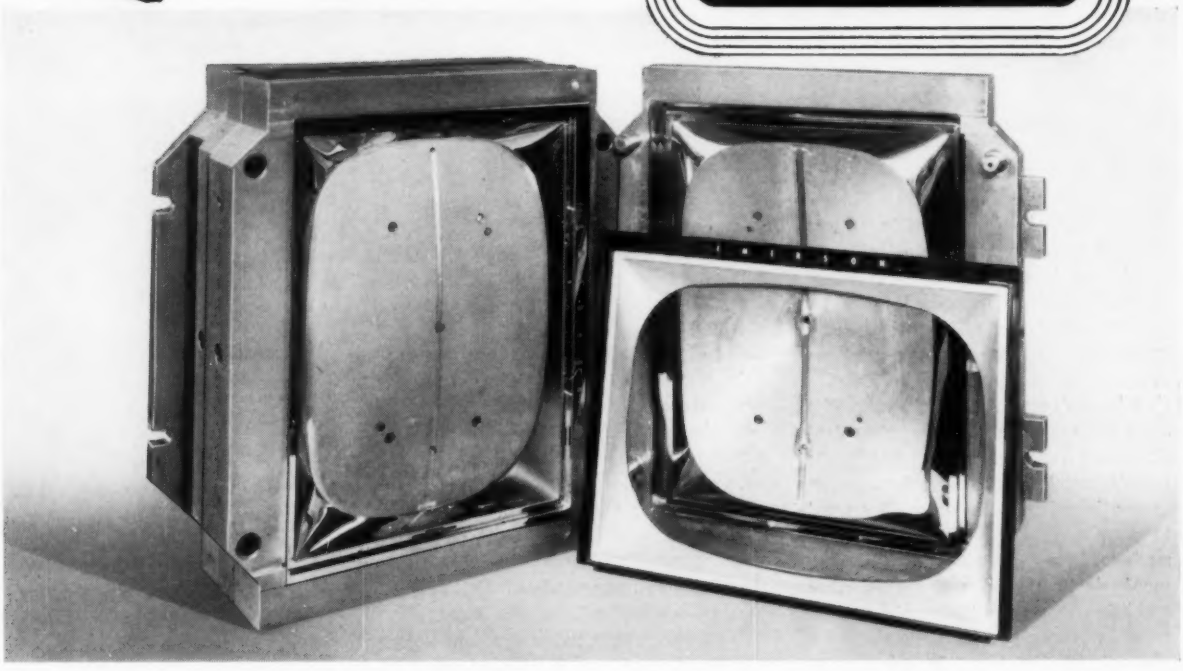

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processing is similar to that of phenolic moldings and the same presses may be used. The application is still in the development stage but appears to be promising.

Molding and Fabricating

SILICONES AS RELEASE AGENTS IN THE PLASTICS INDUSTRY. L. P. Smith. Plastics (London) *19*, 296-97, 311 (Sept. 1954). Four types of silicones have been found useful as release agents: fluids, compounds, resins, and aqueous emulsions of the above materials. The silicone fluids, of which the di-methyl fluid is the most suitable release agent, are ordinarily used as dilute solutions in solvents and are readily applied by dipping or with a low-pressure spray gun. They are most useful when processing has to be done at room temperatures. Silicone compounds, semi-solid agents made by incorporating finely divided silica in a silicone fluid, are most useful when the release agent is required to be applied by hand or brush but can also be dispersed in solvent. They are most useful for pre-treatment of new molds or molds that have recently been cleaned. The silicone resins differ in chemical structure from the silicone fluids, are usually available as solutions in an aromatic solvent, and may be used to prepare a semi-permanent release surface. The aqueous emulsions are particularly useful when operating conditions are such that rapid evaporation of the water present can take place immediately after application and reduce fire hazards by the absence of organic solvents. General rules for proper choice of a release agent and a table of typical applications for silicone release agents in the plastics industry are presented.

BETTER PLASTIC PRODUCTS WITH STATISTICAL QUALITY CONTROL. I. USE OF FREQUENCY DISTRIBUTION DATA IN PLASTICS MOLDING. M. Young and J. A. Kudlock. SPE J. *10*, 20-21, 42 (Sept. 1954). Examples are given of the normal frequency distribution and several abnormal distributions, and the significance of the latter type of distributions in molded parts is discussed. In most cases, a skew distribution indicates that the operation is not performing at its best; in two examples given, it was found that the weigh feeder attached to the press was not functioning properly and that the molder was undercutting the gate. II. THE NORMAL FREQUENCY DISTRIBUTION. N. S. Fay. SPE J. *10*, 28-30, 42 (Oct. 1954). The normal frequency distribution is discussed and the method of defining it by the arithmetic mean and the standard deviation is given. The practical use of these two values in production control is presented. The binomial frequency distribution and the Poisson distribution are also used to describe certain variations in data. III AND IV. THE CONCEPT OF CONTROL CHARTS. D. C. Dague and J. D. Hinchen. SPE J. *10*, 22-27, 30 (Nov.); 21-23, 52, 54 (Dec. 1954). Quality control of attributes is concerned with the presence or absence of a given characteristic or defect and is treated somewhat differently from the quality control of variables, which is concerned with the question "how much" or "to what extent" does the quality characteristic exist. The distribution of defective parts in various samples of a given process may be expressed by the binomial distribution and from this the expected variability expressed as standard deviation may be calculated. A control chart expressing the number of defects rather than defectives can also be set up, using the Poisson distribution. Solutions to the problem of varying sample size in attributes inspection are presented as: 1) maintaining a constant sample size; 2) using an average sample size; and 3) use of the stabilized "p" chart.

Applications

MOLDED DETONATOR CASE. Brit. Plastics *27*, 381 (Oct. 1954). A detonator carrying case made from plastics, for use in mines, is described. The body is made from shock-resistant phenolic, the top from cellulose acetate because of its transparency, and the detonator racks from urea-formaldehyde, held together by strips of plasticized vinyl chloride material. Plastics are being used to replace leather in this use because the safety regulation requiring that such containers be self-locking could not be met by leather cases.

PLASTIC MATERIAL PROBLEMS IN POWER DISTRIBUTION. B. Kellam. SPE J. *10*, 17-21 (Nov. 1954). Three examples of the problems encountered by an electric utility in the use of plastics and the solutions are presented. Polyvinyl chloride plastics have been used for the insulation and sheathing of single and multiconductor control cables since 1945. In one application where cable grippers would cut deeply into the polyvinyl chloride plastic insulation because of cold flow, redesign of the fastener alleviated the undesirable performance. Failures in polyethylene insulation for power cables were attributed to environmental cracking. Black polyethylene sheathed with polyvinyl chloride is being used as a replacement. Limited use has been made of plastic pipe made of polyethylene and of high-impact styrene copolymers. There have been some instances of failures with both of these materials.

Properties

EVALUATING DIELECTRIC PROPERTIES OF PLASTICS LAMINATES. S. W. Place. Elec. Mfg. *54*, 95-102 (Oct. 1954). The results of a detailed long-range program for determining the electrical characteristics of plastics laminates over a wide frequency and temperature range are presented. Dissipation factor and dielectric constant were measured over a frequency range from 10^2 to 10^{10} cy./sec. and at temperatures up to 250° C., depending on the laminate tested. The effect of the direction of the applied field is also discussed. Laminates tested included paper-phenolics, nylon fabric-phenolics, glass mat-polyester, glass mat-melamine, glass-silicone, and glass-Teflon. The latter had the lowest dielectric losses of any of the laminates tested and is satisfactory at operating temperatures up to 250° C. The various laminates are discussed comparatively, and the data are presented in both tabular and graphical form. Design considerations for the selection of plastic laminates for various applications are given.

TEMPERATURE DEPENDENCE OF COMPRESSION OF LINEAR HIGH POLYMERS AT HIGH PRESSURES. C. E. Weir. J. Research Nat. Bur. Standards *53*, 245-52 (Oct. 1954). Pressure-volume-temperature data for polyethylene, polytetrafluoroethylene, polymonochlorotrifluoroethylene, polyvinyl fluoride, polyvinylidene fluoride, polyvinyl alcohol, a copolymer of ethylene-tetrafluoroethylene (1:1), and a polyester are reported over the range 20 to 80° C. and 1 to

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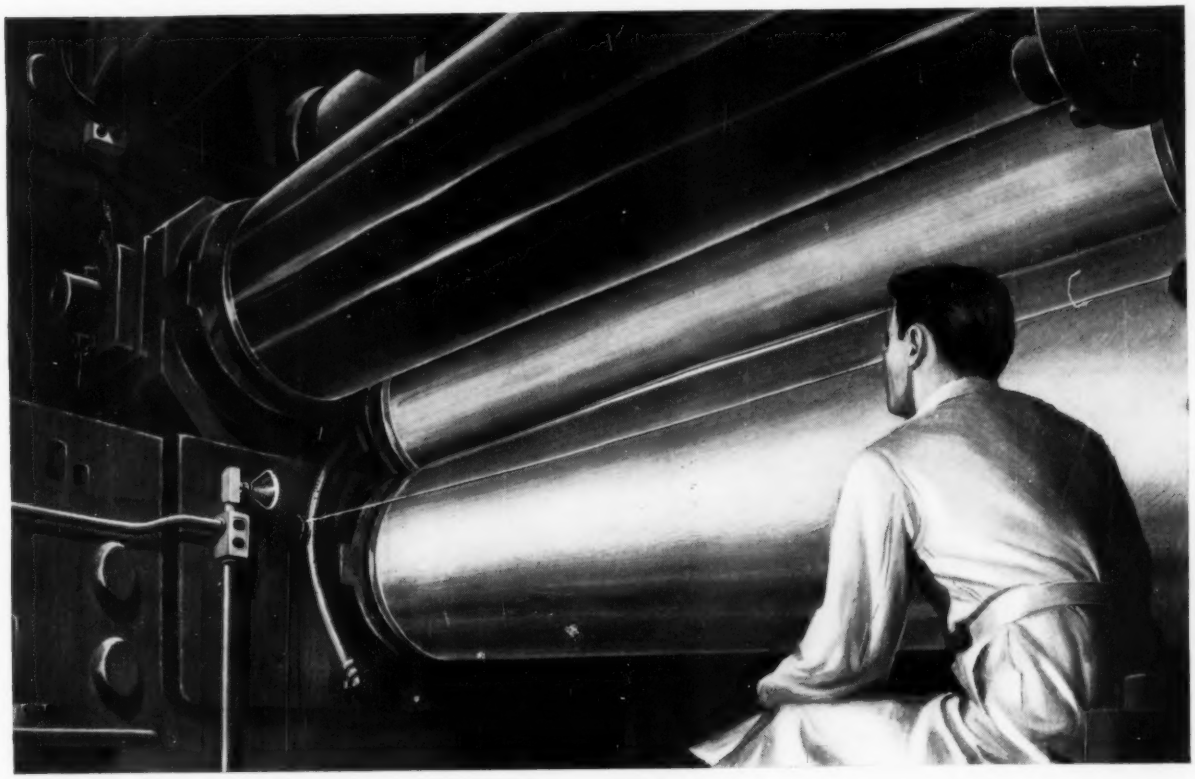

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10,000 atmospheres. Empirical equations of state for some of the polymers are derived. Internal-energy changes were calculated for most of the polymers studied.

MEASUREMENT OF CREEP OF ACRYLIC GLAZING PLASTICS EXPOSED TO TEMPERATURE GRADIENTS. M. C. Slone and F. W. Reinhart. SPE J. *10*, 29-34, 50 (Dec. 1954). A method is described for measuring the creep of aircraft plastic glazing materials under tensile stress with substantially different temperatures on each face. The equipment is described in detail. The operating procedure and methods of calculating the strain and creep rate are presented. The results of tests made with two acrylic plastics, UVA Plexiglas II and Plexiglas 55, indicate that the latter material has a lower elongation and creep rate than the former over the range of temperatures investigated.

EQUILIBRATION IN MOLTEN POLYAMIDE MIXTURES. C. W. Ayers, J. Appl. Chem. *4*, 444-49 (Aug. 1954). A method of partition chromatography was used to discriminate between physical blends of 6,6 and 6,10 nylons and their copolymers. Tests show that copolymerization proceeds rapidly when under nitrogen. Chain length equilibration is rapidly attained and compositional rearrangement proceeds coincidentally. The chromatographic test is particularly valuable in following this latter process. It has, however, the limitation that, although indicating the progress of chemical randomization, it becomes increasingly less sensitive as the product more nearly approaches true randomness. In other words, it is an ideal test for indicating block copolymerization, a field where X-ray and infra-red analysis appear to be inoperable.

DYNAMIC PROPERTIES OF PLASTICIZED POLYVINYL CHLORIDE. M. G. Dilke and J. J. Millane. J. Appl. Chem. *4*, 507-513 (Sept. 1954). An apparatus for measuring the dynamic mechanical properties of plasticized polyvinyl chloride is described. The dynamic modulus, dynamic resilience, and dynamic loss factor for polyvinyl chloride plasticized with 33.3, 25, and 5% of di-(2-ethylhexyl) phthalate were measured at temperatures between −10 and 100° C., at vibration frequencies between 30 and 450 cycles per sec-

ond. The results indicate a close correlation between mechanical and electrical properties and this relationship is discussed.

Testing

DETERMINATION OF CARBOXYL END GROUPS IN A POLYESTER, POLYETHYLENE TEREPHTHALATE. H. A. Pohl. Analytical Chem. *26*, 1614-16 (Oct. 1954). A semimicroprocedure for the rapid determination of the carboxyl end groups of the polyester, polyethylene terephthalate, entails dissolving the polymer in benzyl alcohol rapidly at a high temperature (203° C.), then quickly mixing the solution with chloroform, and titrating with the aid of a phenol red indicator and sodium hydroxide. About 10 min. are required for an analysis, including weighing. An additional 5 or 10 min. may be required if the polymer sample needs grinding. To aid precise dispensing of the reagents, a simple automatic pipet or buret is used.

REACTIONS AND IDENTIFICATION OF POLYVINYL AND POLYACRYLIC COMPOUNDS. H. Rath and L. Heiss. Kunststoffe *44*, 341-47 (Aug. 1954). The identification of polyvinyl and polyacrylic compounds in very small quantities is very difficult. The following reactions were used to differentiate between the two compounds. 1) The polyvinyl compounds were converted to polyenes which can be identified from certain colors. A differentiation of the single polyvinyl members was achieved by adding different polyene-forming agents. 2) The identification of polyacrylates and polymethyl methacrylates was achieved by converting them into carbinols through the addition of phenyl lithium, in analogy to the reaction of esters of low molecular weight. The carbinols have characteristic color reactions with various agents.

Publishers' Addresses

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Copies of these patents are available from the U.S. Patent Office, Washington, D.C., at 25¢ each.

SEALING. E. A. Olson. U. S. 2,691,474, Oct. 12. Heat sealing plies of polyvinyl chloride.

POLYMERS. D. E. Kyalnes and N. O. Brace (to Du Pont). U. S. 2,691,567, Oct. 12. Polymeric organic phosphorus compounds.

PHOTOSENSITIVE FILM. J. G. Smith and L. M. Miusk (to Eastman Kodak). U. S. 2,691,584, Oct. 12. Stabilized photosensitive polyvinyl cinnamate.

COATING. W. J. Priest (to Eastman Kodak). U. S. 2,691,604, Oct. 12. Coatings of polyvinyl alcohol-methylolmelamine.

POLYMER. H. H. Synder (to Du Pont). U. S. 2,691,609, Oct. 12. Polymeric styrene–maleamic acid compositions.

CONTAINER. C. A. Baer. U. S. 2,691,613, Oct. 12. Method of fabricating plastic envelopes.

ADHESIVE. M. W. Wilson (to B. F. Goodrich). U. S. 2,691,614, Oct. 12. Phenolic adhesive for rubber.

RESINS. H. M. Kvalnes and L. T. Sherwood, Jr. (to Du Pont). U. S. 2,691,638, Oct. 12. Urea-formaldehyde condensates.

MOLDING COMPOSITIONS. H. H. Roth (to Dow). U. S. 2,691,639, Oct. 12. Water-dispersed thermoplastics.

COPOLYMERS. H. T. Patterson and I. D. Webb (to Du Pont). U. S. 2,691,640, Oct. 12. Acrylonitrile-dimethylamino-methylstyrene copolymers.

STABILIZED RESIN. D. Faulkner (to Distillers). U. S. 2,691,642, Oct. 12. Stabilized polyvinylidene chloride.

POLYPEPTIDES. J. S. Chirtel and A. M. Mark (to Transparent Package). U. S. 2,691,643, Oct. 12. Polypeptides of beta-alanine.

SULFONATED RESIN. H. H. Roth (to Dow). U. S. 2,691,644, Oct. 12. Sulfonated alkenyl aromatic resin.

COPOLYMERS. G. E. Ham (to Chemstrand). U. S. 2,691,645, Oct. 12. Copolymers of acrylonitrile and beta-haloethylvinyl ether.

COPOLYMERS. D. W. Young and W. J. Sparks (to Standard Oil). U. S. 2,691,646, Oct. 12. Copolymers of multi-olefins with vinyl ethers.

POLYMERS. E. Field and M. Feller (to Standard Oil). U. S. 2,691,647, Oct. 12. Polymerization of ethylene and propylene.

CONDENSATES. H. S. Bloch (to Universal Oil). U. S. 2,691,686, Oct. 12. Condensates of aromatic compounds with cyclic polyolefins.

INSULATION. H. R. Young (to Du Pont). U. S. 2,691,694, Oct. 12. Electrical conductors insulated with polytetrafluoroethylene and glass fiber.

SHEETING. J. W. Emig (to Armstrong Cork). U. S. 2,691,796, Oct. 19. Making variegated plastic sheet material.

TRIMMING. W. Bertleft and L. E. Hoffer (to Eagle-Picher). U. S. 2,691,797, Oct. 19. Trimming molded articles.

MOLDING. J. H. Winchester and M. Achterhof (to Eagle-Picher). U. S. 2,691,798, Oct. 19. Molding apparatus.

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BEARINGS. W. H. Tait (to Glacier Metal). U. S. 2,691,814, Oct. 19. Polytetrafluoroethylene impregnated bearings.

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INLAID CIRCUITS. N. Pritikin. U. S. 2,692,190, Oct. 19. Inlaid circuits on plastic material.

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POLYMERS. M. M. Swarc. U. S. 2,692,243, Oct. 19. Heterocyclic polymers containing nitrogen and methylene groups.

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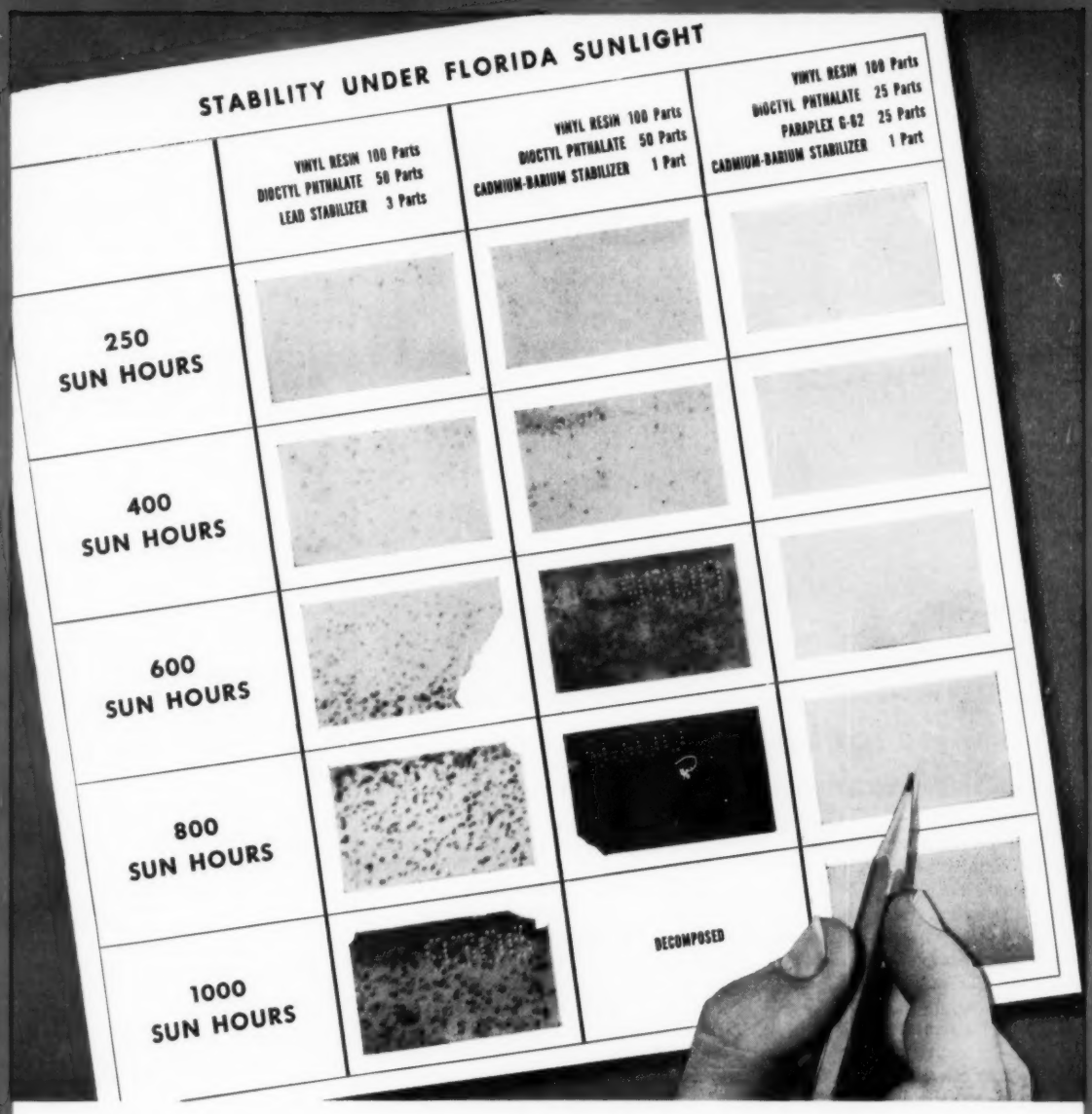
RESIN. T. G. Harris (to Catalin). U. S. 2,692,865, Oct. 26. Modified phenolic resin.

ION EXCHANGE. K. Haagen (to Far-



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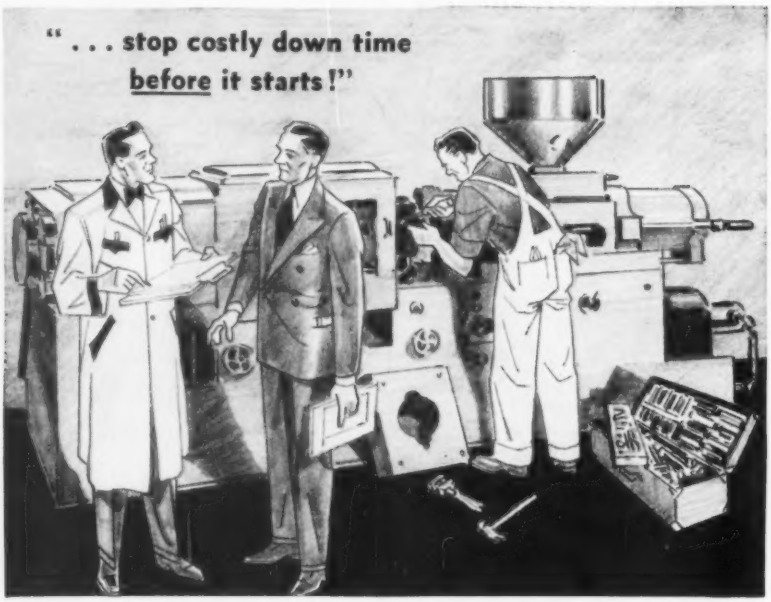

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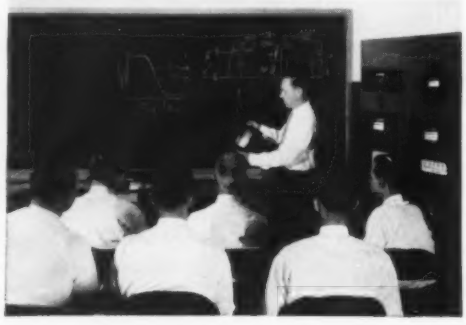

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benfabriken Bayer). U. S. 2,692,866-7, Oct. 26. Cation-exchange resins from phenolic ethers.

POLYMERS. K. L. Berry and P. L. Salzberg (to Du Pont). U. S. 2,692,-868, Oct. 26. Silica-containing polymers.

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ELASTOMERS. E. O. Langerak, L. J. Prucino, and W. R. Remington (to Du Pont). U. S. 2,692,873-4, Oct. 26. Elastomers from polyalkylene ether glycol reacted with arylene diisocyanates.

COPOLYMERS. H. H. Weinstock, Jr. and G. A. Nesty (to Allied Chemical). U. S. 2,692,875, Oct. 26. Methacrylonitrile-acrylonitrile copolymers.

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PLASTIC. C. F. Fisk (to U. S. Rubber). U. S. 2,693,459, Nov. 2. Composition of polyvinyl acetal and chlorosulfonated polyethylene.

ACRYLONITRILE. A. P. Guess and W. B. McCaskill (to Du Pont). U. S. 2,693,462, Nov. 2. Polymerization of acrylonitrile.

MOLDING. L. L. Stott (to Polymer). U. S. 2,696,023, Dec. 7. Molding polyamides.

CASTING. E. L. Mobley and R. P. Molitor (to Sun Rubber). U. S. 2,-696,024, Dec. 7. Rotational casting of hollow vinyl resin articles.

FLOOR COVER. I. I. Bezman (to Armstrong Corp). U. S. 2,696,447, Dec. 7. Vinyl-coated felt base floor covering.

AIRCRAFT CLOSURE. E. H. Snyder (to Lockheed). U. S. 2,696,451, Dec. 7. Plastic closure.

FLOOR COVERING. S. G. Trepp (to Bird and Son). U. S. 2,696,452, Dec. 7. Vinyl floor cover.

CONDENSATES. D. M. Gagarine and H. Repokis (to Dan River Mills). U. S. 2,696,477, Dec. 7. Acrolein-formaldehyde condensates.

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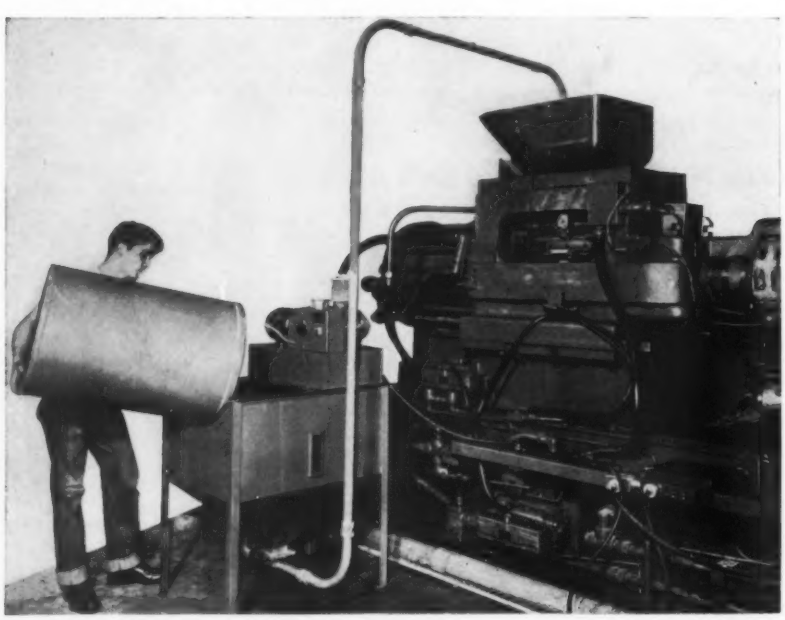
Hydraulic Press—Model 60-12 hydraulic press is designed for laboratory and production use. Available with a choice of electrically heated 12- by 12- and 14- by 14-in. platens, the unit is equipped with individual controls to regulate hydraulic pressure for each operation within a range of 50 to 400 p.s.i., the hydraulic pressure aggregating 60-ton capacity. The press is powered by an air-operated boost pump claimed to maintain accurate and consistent pressure on the platen area at all times.

The machine's cooling system is said to reduce transfer of heat from platen to ram, ram pot, hydraulic oil, and packing. *Atlas Hydraulics, Inc., 3576 Ruth St., Philadelphia 34, Pa.*

Drying Accessory—Automatic hopper-loader for use with D & W hopper-dryers conveys material from bin into the hopper on the drying machine by means of heated air from a standard blower unit, eliminating the necessity of connecting into a compressed-air line. The loader can be connected to D & W hot air blower units and hoppers. A combination hopper-loader and hopper-dryer is also available. With that unit, the drying of material would be done in the bin and the material then conveyed up into the hopper on the machine. *Thoreson-McCosh, Inc., 18208 W. McNichols Rd., Detroit 19, Mich.*

Sponge Tester—Machine measures deflection and load-carrying capacity of sponge and foam samples; attachments for determining percent change in deflection and load-carrying capacity at different temperatures are available.

The unit consists of two parallel movable platens, a dial gage, and a spring scale. The upper platen is raised and lowered by a $\frac{1}{20}$-hp. motor. The lower platen is attached to a shaft in the top of the spring scale. The base of the scale is fitted with an arm on which rests the adjustable dial gage. This gage measures the height of the specimen at any given deflection in thousandths of an inch. The unit has a scale ranging from zero to 20 pounds. *Castle Machine Manufacturers, New Castle, Del.*



Thoreson-McCosh's hopper-loader attachment uses heated air from a standard blower unit to convey material from a bin into the hopper mounted atop a drying machine

Low-Pressure Presses—Line of oil hydraulic C-frame presses for low-tonnage applications includes 11 sizes: 2-, 5-, 10-, 15-, 25-, 35-, 50-, 75-, 100-, 150-, and 200-ton models. Operating controls include single- or dual-safety operating levers, electric push-button, foot switch, foot pedal, and other standard types. High-speed differential circuit and inching control are included. An open C-gap frame eliminates encumbrances within the tooling area and provides a maximum amount of room for tooling. Relief valves are said to provide an infinite range of tonnage regulation on all models.

Production tooling accessories include standard bolsters, benches, bed extensions, straightening fixtures, hydraulic knockouts, die cushions, and many others. *The Hydraulic Press Mfg. Co., Mount Gilead, Ohio.*

Vacuum Forming Machine—Series PEX automatic and semi-automatic presses for vacuum and drape forming are designed to permit parts of dissimilar height to be formed simultaneously at the two ends of the machine. A center-mounted heating unit is hinged for swinging to either side of the machine. Power is adjustable from 200 to 1550 w./sq. inch. Two sets of timers are provided so that the machine will operate fully automatically from side to side or or either side. *Comet Industries, 9865 Franklin Ave., Franklin Park, Ill.*

Surfacing Machine—Designed for high-production planing of thin, flexible materials (e.g. vinyl tile and shoe soling material), the Micro-Surfacer has adjustments graduated in thousandths of an inch.

In operation, stock is transferred in and out of the Micro-Surfacer by built-in, power-driven conveyors. A cutter head, equipped with Carboloy knives, rotates at 4500 r.p.m. in the direction of the feed. Stock is fed past the rotating cutter head by

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H-250

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Check these outstanding features of this ultra-modern Van Dorn injection press:—

GREATER CAPACITY— Up to 2½ oz.; smaller pieces at faster cycles.

HI-SPEED PERFORMANCE— Plasticizes material at 22 lbs. plus per hour.

FASTER PRODUCTION—Will attain up to 720 cycles per hour (dry run).

HIGHEST EFFICIENCY—Due to water cooling of injection plunger, transfer hopper and oil cooler.

ACCESSIBILITY— Due to simple platen clamp device for purging to change material or color.

MORE SAFETY— Mold hydraulic mechanism makes press non-operative unless molded part is completely ejected.

SIMPLER OPERATION—Due to automatic, adjustable material metering device.

MULTIPLE OPERATIONS—Minimum operator attention by use of larger hopper and light that indicates when press needs attention.

SELECTIVE CONTROL—Merely throw toggle switch to operate press semi-automatically.

DEPENDABILITY— Because of all-steel construction and Van Dorn's established reputation in the plastics machinery field.

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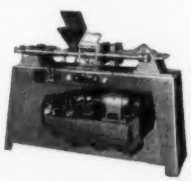
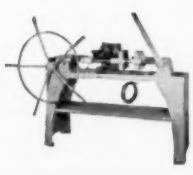
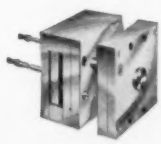


POWER OPERATED, LEVER CONTROLLED PRESSES
2-oz. and 1-oz. models

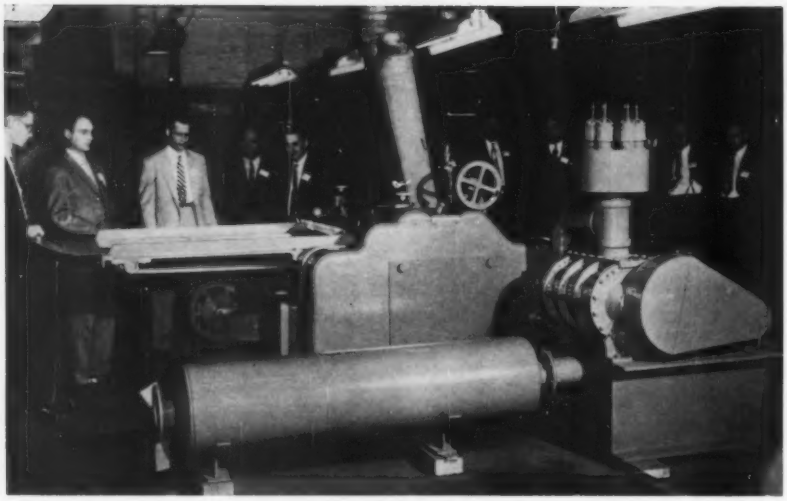


MANUALLY OPERATED PRESS
1-oz. For small jobs, training, etc.

PLASTIC GRINDER
Grinds up rejects, waste, etc., for re-use.



MOLD BASES
Available from stock.



Buss Machine's Micro-Surfacer, shown being demonstrated to a group of industry representatives, can plane thin, flexible material, such as vinyl tile, shoe soling material, etc.

means of two rolls located before the cutter head and two located behind it. Guide shoes located on both sides of the cutter head and set above the material being planed do not touch the stock. They are equipped with "fingers" that prevent the stock from stopping in the machine and also act to direct the flow of shavings up an exhaust hood. Flexible material is held down rigidly during the planing operation by means of a ground and lapped vacuum work table and a vacuum pump system which is regulated by pressure relief valves. Feed range of the machine is infinitely variable.

At present, the machine is available in widths up to 50 inches. *Buss Machine Works, Holland, Mich.*

Duplicators—Four-spindle duplicators are claimed to profile (continuously or with interruptions) internal or external surfaces and to groove or rout parts at high production rates. Heads and rotating fixtures operate in pairs, each pair of fixtures being governed by a separate master. Masters, one for each pair, are located within the table assembly. This design permits one pair of identical parts to be processed by one pair of cutters and fixtures, while the other pair performs a different operation on two other pieces.

In operation, after cutter spindles have been set for the required cutting depth, fixtures holding the work by air-operated clamps rotate and move in and out from column face, guided by the concealed master. All movements are protected by electrical interlocks. *George Gorton Machine Co., 1321 Racine St., Racine, Wis.*

Edge Positioning—For use on continuous-web operations, differential pressure web edge sensing unit provides electric signal and current for left and right correction and neutral position. The device is said to pilot any electric motor-operated, solenoid valve-operated, or hydraulic- or air-operated web system. The unit can be adapted, by cutting down the metered air supply, so as to prevent response to momentary web imperfections or run-outs. On a weaving web, the instrument will closely compute the average position of the web and correct it accordingly. Claimed accuracy of the device is down to 0.01 in. within a fraction of a second reaction time. Air pressure of about 1 oz., and air flow of from 5 to 20 cu. ft./hr. are used. This is said to be so low that the air jet will not disturb even the most delicate materials. *H. G. Weber & Co., Kiel, Wisc.*

Injection Machine—Model 16ES-400 16-oz. horizontal injection machine is a fully hydraulic unit with a rated 400-ton clamping force. The machine is equipped with radial piston-type motor driven pumping unit, semi-automatic control, and independent control of injection and clamping pressures. Mold area dimensions are 34-in. opening, 22-in. stroke, and 20- by 36- or 31- by 33-in. mold space. A special weigh feeding mechanism is optionally available. *Watson-Stillman Co., Div. of H. K. Porter Co., Inc., Roselle, N. J.*

Weigher-Counter—Scales that are claimed to count hundreds of parts accurately in a few seconds also produce a printed record of both the weight and the count. Designated Printweigh counting scales, the units can print any count up to 9999 simultaneously with the weight figure. These scales are available in bench, portable, floor, and built-in types. *Toledo Scale Co., Toledo 1, Ohio.*

Abrasion Tester—Model 140PT portable abrasion testing machine evaluates wear resistance of plastic, rubber, electroplates, and other surfaces. Two dual abrading wheels are used to produce rub-wear action. One wheel rubs the specimen from the center outward, the other from the outside toward the center. Abrasion marks are in the form of two arcs criss-crossing each other and covering an area of approximately 30 sq. cm. (sufficient for rating most materials).

Results of tests are said to be easily read and to require a minimum of technical experience. The instrument is reported to perform most of the functions of the standard laboratory model 140 while being priced lower. *Taber Instrument Corp., North Tonawanda, N. Y.*

Sealing Machine—High-frequency generator for dielectric heat sealing is said to operate within the FCC-allocated limits of the 27-mc. industrial band, eliminating need for a shielded room.

The generator has a single-dial selector for a range of sealing capacities. The unit is available in 1- and 2-kw. models. *Industron Corp., 50 Brooks Rd., Needham Heights, Mass.*

Heat Sealers—Model DH 2900 electronic heat sealer, rated at 2.9 kw., is equipped with an Arquench, said to prevent die damage, and a safety device stated to meet safety requirements of most states. The manufacturer of the equipment claims that it is the lowest priced unit available today for this power and these standard features.

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sealing dies protected against handling damage and deterioration by a process involving protective coverings and rubber covering along the sealing edges. *Kabar Mfg. Corp., 1907 White Plains Rd., New York, N.Y.*

Preheater—Model 230 for the preheating of compression and transfer molding materials such as phenolic, urea, melamine, etc., is said to heat loose powder or granular molding compounds equally as well as preformed materials.

The unit is claimed to heat 2 to 3 lb./min., with a maximum compound capacity of 10 pounds. It incorporates an air-operated hood, eliminating manual opening and closing operations. Size of the unit is 24 in. wide, 27 in. deep, and 56 in. high; work level is 50 in. high, weight is 450 pounds. Electrode size is 12 by 12 in., maximum electrode opening is 5 in., time control is variable up to 2½ min., maximum power output is 3½ kw., and dual-interlock switches are provided for electrical and mechanical safety. Unit is certified to meet all FCC rules. *W. T. LaRose & Associates, Inc., Troy, N. Y.*

W. T. LaRose's Model 230 electronic preheater heats powder or granular material equally as well as preformed material

Welding Equipment—Lightweight (14 oz.) electric hot-gas welding gun for use in thermoplastics processing, operates on 110 v. with a choice of 180-, 240-, and 320-w. elements. The welding medium is generally electrically heated compressed air, although for some purposes nitrogen or carbon dioxide are used. *Seelye Craftsmen, Industrial Plastics Div., 984 Central Ave., Minneapolis, Minn.*

Tapping Head—Semi-automatic and fully automatic lead screw tapping heads for tapping holes in plastics and metals, said to be operable on any drill press, use standard Bellows air motors and Electroaire valves for activating the clutch mechanism. Starting impulse can be suited to the user's need; a fixed return Microswitch completes the cycle. Tap breakage and work spoilage are claimed to be reduced because the lead screw takes all end thrust and guides the tap in both directions. Positive mechanical depth control permits blind holes to be tapped accurately. Units are said to attach readily to the quill of most standard drill presses. Two models are available for tapping to 5/16 in. (Model 800) and to ¾ in. (Model 900). *Automatic Methods, Inc., 965 W. Grand St., Elizabeth, N.J.*

Heating Bands—Knitted electrothermal heating tape finds industrial application on pipes, spray guns, injection molding machines, and other equipment. The tape can be stretched or squeezed to fit on the equipment to be heated. The current-carrying resistance bands are insulated on both sides by layers of knitted glass yarn, making it possible to use the tape directly on metal. The tape is furnished in ½-, 1-, 2-, and 3½-in. widths in lengths of 2, 4, 6, and 8 feet. *Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.*

Sealing Equipment—Semi-automatic machine for sealing polyethylene tubes of ⅜- to 2⅜-in. diameter operates on the gang principle and is claimed to be the only device of its kind to seal several tubes at one time. The unit has a station for filling and a station for sealing the tubes. Rated production capacity is from 10 to 30 units per min., dependent upon diameter. Installation can be made wherever a 110-v., 60-cycle line and 60-lb. air pressure are available. *Carbert Mfg. Co., Inc. 144 Moody St., Waltham, Mass.*

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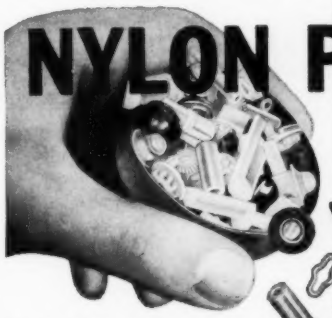

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BOOKS AND BOOKLETS

Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationery.

"Atoms for Peace," by David O. Woodbury

Published in 1954 by Dodd Mead & Co., 432 Fourth Ave., New York, N.Y. Price: $3.50.

A non-technical, well executed presentation of the various peacetime uses of atomic energy. The fields covered by the author include medicine, science, and industry. Plastics come in for their share of mention, particularly in regard to the irradiation of polyethylene to produce a material with improved heat resistance.

"Glass Reinforced Plastics," edited by Phillip Morgan

Published in 1954 by Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. 248 pages. Price: $10.00.

The editor of this volume — who is also editor of *British Plastics* — has compiled a series of articles that give a comprehensive picture of the current status of glass-reinforced plastics. The various contributors to the volume cover forms and properties of glass fibers, the chemistry of unsaturated polyester and allyl resins, polyester types and properties, commercial molding processes, mass production techniques, structural designs and properties, and applications in the aircraft, automotive, marine, and other industries.

"Adhesion and Adhesives," edited by F. Clark, J. E. Rutzler, Jr., and R. L. Savage

Published in 1954 by Society of Chemical Industry, 56 Victoria St., London S. W. 1, England; distributed in the United States by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 229 pages. Price: $9.75.

Papers dealing with the theory and practice of adhesion, presented at a symposium held at Case Institute of Technology and a conference sponsored by the Society of Chemical Industry (England) have been collected into this volume. They constitute a concise survey of the status of basic knowledge in the field. The work is divided into two parts. The first deals with fundamentals and covers such topics as "Survey of Adhesion and Types of Bonds Involved," "Energy of Adhesion, Molecular Forces, and Adhesive Rupture," "The Part Played by Fluids in Adhesion," "The Mechanism of Adhesion," and many others. The second part is concerned with practical aspects of adhesion and investigates such subjects as "Types and Uses of Adhesives," "Adhesives for Glass," "Aircraft Structural Adhesives," "The Adhesion of Metals," as well as adhesive practice for numerous other materials and combination of materials. Discussions following the presentations of the papers are included.

"The Practical Engineer," edited by N. P. W. Moore

Published in 1954 by Pitman Publishing Corp., 2 W. 45th St., New York 36, N. Y. 744 pages. Price: $3.00.

Working information most frequently needed by the practical engineer has been collected into this extremely handy and helpful pocket-size (3½ by 6 in.) book. Covered are pipes, beam, columns, springs, bearings, cranes, pyrometry, metallurgy, steam, condensers, gas turbines, hydraulics, lubrication, and a host of other aspects of mechanics. Tables, diagrams, and formulas are presented in profusion. Sections on the conversion of units of measurement, as well as brief technical dictionaries in German, French, and Spanish, are included.

"Cellulose and Cellulose Derivatives Part II," edited by Emil Ott, Harold M. Spurlin, and Mildred W. Grafflin

Published in 1954 by Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y. 545 pages. Price: $12.00.

Second of a three-part definitive treatment of cellulose and cellulosics, this volume is concerned with the problems involved in the preparation of cellulose from its natural sources; bleaching and purification of wood cellulose; properties and treatment of pulp for paper; and derivatives of cellulose, including inorganic and organic esters, alkali and other metal derivatives, ethers, and xanthates. A chapter on the degradation of cellulose derivatives is included. Part I was reviewed in MODERN PLASTICS *32*, 178, December 1954.

Counting scales—Form 2208 describes a line of count-weighing scales, including fan, bench, portable, floor, and built-in types. Specialized count-by-weight units include triple-ratio and variable-ratio models, as well as the combination of Printweigh selective numbering with counting to provide a printed weight-count system. *Toledo Scale Co., Telegraph Rd., Toledo 1, Ohio.*

Tetrafluoroethylene—This splendid booklet discusses in detail properties and uses of Teflon, as well as processing techniques. Among the latter are molding, ram extrusion, calendering, extrusion, casting, dip coating, and impregnation. Also included are sections on the use of fillers, products made of Teflon, fabricating techniques, and coloring methods. *E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington 99, Del.*

Nylon-6 — Chemical and physical properties of Perlon, a polyamide of the nylon-6 type, are presented in this 16-page brochure. Extrusion and injection molding procedures are covered. *Alfred C. Toepfer, Inc., 1 Broadway, New York 4, N. Y.*

Plastics research—Proceedings of the plastics and polymer group of the Society of Chemical Industry of England (Vol. V, 1953) contains 21 papers reprinted from the *Journal of Applied Chemistry and Industry*, including "The Osmometry of High Polymers," "The Mechanical Properties of Plastics," "Depolymerization Reactions of Vinyl Polymers," and others. $4.20. *Society of Chemical Industry, 56, Victoria St., London S.W. 1, England.*

Inserts—Bulletin 715-A contains selection tables, line drawings showing proper installation in blind and through holes, and instructions on use of screw-lock inserts with constricting grip-coil at the bottom of the insert. Locking force which holds the screw or stud is claimed to eliminate the use of lock-washers, lock-

Kenneth B. Welch, Pres. (left) and Roger R Sacia, V. P., Kenro Corporation, discuss the uniform high quality of their "Holiday" dinnerware.

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nuts, and lock wires. The screw-lock insert meets AN-N-5b and similar governmental specifications for high temperature applications. *Heli-Coil Corp., Danbury, Conn.*

Fluorocarbon filters — Several types of porous Kel-F filters are described and data are given on pore size, particle size removal, and flow capacity. Also included is information on properties of porous Kel-F. *Porous Plastic Filter Co., 30 Sea Cliff Ave., Glen Cove, N. Y.*

Ethyl benzene—Information on ethyl benzene is presented in Bulletin F-8596. High-purity ethyl benzene is commercially available for synthesis and solvent uses. In vinyl-type polymerizations, it promotes the formation of low-molecular-weight resins that are of particular interest in adhesives, coatings, and viscosity index improvers for lubricating oils. Ethyl benzene is a raw material for drugs and chemicals and is suggested for trial as a starting point in the manufacture of dyestuffs and detergents, and as an extraction solvent. *Carbide and Carbon Chemicals Co., 30 E. 42nd St., New York 17, N. Y.*

Glycol carbonates—Ethylene carbonate and propylene carbonate are described in eight-page technical bulletin F-8307. Typical reactions and a selection of literature references are included. *Carbide and Carbon Chemicals Co., 30 E. 42nd St., New York 17, N. Y.*

Reinforced plastics — Product standards for translucent fibrous glass-reinforced panels are presented in "What to Look for in a Good Translucent Building Panel." Sample specifications are furnished. *Corrulux Div. Libbey-Owens-Ford Glass Co., Nicholas Bldg., Toledo 3, Ohio.*

Dyeing synthetic fibers—A detailed analysis of the methods and materials available for dyeing synthetic fibers is presented in the fourth edition of Brochure GS-66. *General Dyestuff Co., a Sales Div. of General Aniline & Film Corp., 435 Hudson St., New York 14, N. Y.*

Flexible engraving stock — Catalog sheet describes characteristics of a flexible laminated engraving stock that can also be embossed, stitched, stapled, and stamped. Tradenamed Gravoflex, the material is laminated in layers of two contrasting colors. When engraved through the top layer, lettering is said to stand out permanently on contrasting background. *Hermes Plastics, Inc., 13-19 University Pl., New York 3, N. Y.*

Facilities and services—Design-through-production facilities in the three basic lightweight materials—reinforced plastics, aluminum, and magnesium—are described in this 24-page booklet. *East Coast Aeronautics, Inc., 10 Pelham Parkway, Pelham Manor, N. Y.*

Contract research—Facilities, services, and personnel for conducting industrial research on a contract basis are described in this 24-page booklet. Services offered range from product development to automation to customer relations. *Batelle Memorial Institute, Columbus 1, Ohio.*

Colorants—Technical Bulletin 130 describes a series of 19 color paste concentrates for coloring epoxy, Thiokol, polyurethane, and isocyanate resins. Mixing data are presented. *Claremont Pigment Dispersion Corp., 110 Wallabout St., Brooklyn 11, N. Y.*

Light diffuser—Translucent corrugated vinyl ceilings suspended to the desired level below rows of fluorescent light sources, are described in this 16-page brochure. The ceilings provide diffused room illumination over the entire area, giving uniform distribution and eliminating shadows and glare. They also act to reduce noise level and serve as air distribution devices. Specifications, installation instruction, and light-element dimensions are given. *Luminous Ceilings, Inc., 2500 W. North Ave., Chicago 47, Ill.*

Bulk chemicals—Catalog 116-C lists over 100 reagent chemicals available in bulk, giving pound-per-drum and price-per-pound information. Specifications for each compound are given. *Fisher Scientific Co., 711 Forbes St., Pittsburgh 19, Pa.*

Pressure sensitive tape—Brochure outlines activities of the Pressure Sensitive Tape Council, including its work on standardization in nomenclature and test methods within the pressure-sensitive tape industry. The brochure also lists the members of the council who are producing and marketing pressure-sensitive cloth and paper tapes. The council is not concerned with surgical or medical, cellophane, acetate fiber, or plastic film tapes. *The Pressure-Sensitive Tape Council, 530 Echo Lane, Glenview, Ill.*

Structural polyethylene—Structural applications of polyethylene in welded units, especially where lightness and corrosion resistance are decisive factors, are outlined in this six-page report. Typical fabrication methods and welding operations are illustrated. *American Agile Corp., P. O. Box 168, Bedford, Ohio.*

Pipe accessories—A line of injection molded, unplasticized polyvinyl chloride pipe fittings and flanges is presented in this four-page folder. Included are elbows (90° and 45°), pipe tees, caps, couplings, reducing bushings, pipe flanges, and blind flanges. Physical properties, available sizes, and suggested maximum fluid pressures are listed. *Tube Turn Plastics, Inc., 224 E. Broadway, Louisville 1, Ky.*

Ethyl acetate—Uses of ethyl acetate and its physical and physiological properties, specifications, shipping data, and constant-boiling mixtures are discussed in Booklet F-8140. Graphs on vapor pressures, specific gravities, freezing points, and other physical properties are included. Comparative information on resin solubilities, general solvent properties, and viscosity of lacquer formulations is also given. *Carbide and Carbon Chemicals Co., 30 E. 42nd St., New York 17, N. Y.*

Glass mat—Technical information on a line of glass mat reinforcements is listed in a series of data sheets. The mat is made by cutting 14,000 yd./lb. continuous strands into 2-in. lengths and depositing them in random pattern in a continuous length of bonded mat. *Fiberglas Div., Ferro Corp., 200 Woodycrest Ave., Nashville, Tenn.*

Industrial preparedness—Problems faced by American industry in protecting its plants against the dangers of sabotage and espionage, as well as those arising out of enemy attack, are briefly outlined in this 12-page booklet, entitled "Job for Manage-

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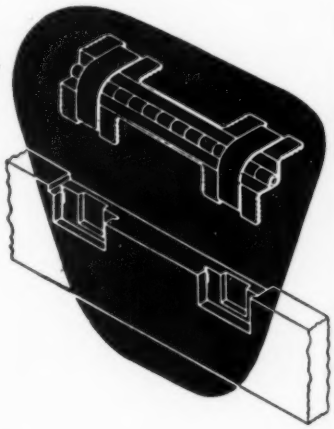

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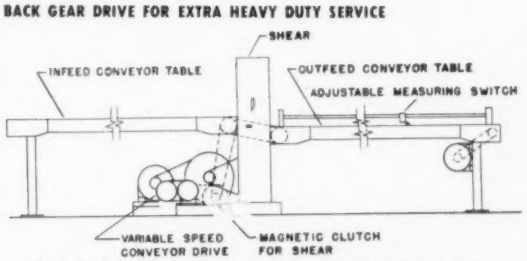

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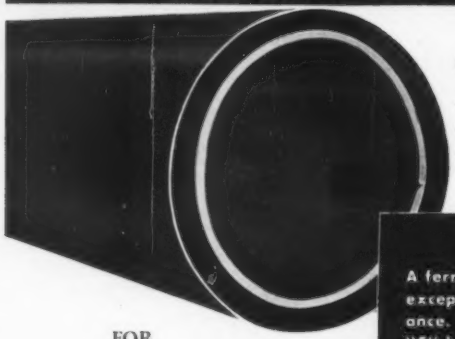

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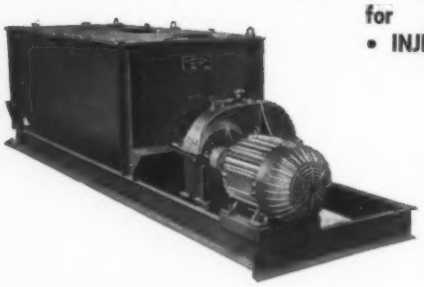

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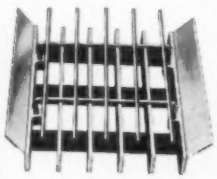

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ment." Specific steps to be taken by companies in preparation for defense and disaster are indicated. *U. S. Dept. of Commerce, Business and Defense Services Administration, Washington 25, D. C.*

Finishing—Over 35 applications of the wet abrasive blasting process are described in this 18-page Bulletin 541-D. The process itself (in which water-suspended abrasives are thrown at high velocity upon the work) and necessary equipment are also covered. *American Wheelabrator & Equipment Corp., Mishawaka, Ind.*

Automation—Entitled "Calling All Jobs," this 24-page booklet aims at allaying workers' fears of losing employment because of automation. It emphasizes that so-called "workerless" plants are a myth and will remain so in the future. The booklet uses historical examples to show that every improvement of the machine age which has increased productivity has increased the number of jobs, thus proving that automation is the friend of the worker rather than his enemy. *National Association of Manufacturers, 2 E. 48th St., New York 17, N. Y.*

Plastisol products—Typical methods of manufacturing finished products from vinyl plastisols, using such methods as spread-coating, dip-coating, and spray-coating, are outlined in this four-page data sheet. Information on physical properties of plastisols, storage life, and necessary heating equipment is included. *The B. F. Goodrich Co., Industrial Products Div., Akron, Ohio.*

Solvents—"Cellosolve and Carbitol Solvents" describes in detail nine commercial glycol-ethers. A section on specifications of the glycol-ethers and tests methods is included. Glycol-ethers, which are completely water soluble, are powerful, mild-odor solvents for cellulose esters. They are also used as intermediates for a number of plasticizers. *Carbide and Carbon Chemicals Co., 30 E. 42nd St., New York 17, N. Y.*

Oils—Catalog and wholesale price list covers essential oils, sesquiterpeneless and terpeneless oils, floral absolutes, floral concretes, aromatic chemicals, balsams, gums, tinctures,

oleoresins, and similar chemicals. Available only to those whose purchases are in wholesale quantities. *Fritzsche Bros., Inc., 76 Ninth Ave., New York 11, N. Y.*

Chemicals for better living—A collection of 15 full-page, four-color advertisements, published by a major chemicals company in two national weekly news magazines during the past few years, depicts the contributions of that company to the American way of life and standard of living. The field to which these contributions were made include agriculture, drycleaning, dairy products, glass, ink, leather, metal finishing, paints, paperboard, plastics, rubber, and textiles. *Diamond Alkali Co., 300 Union Commerce Bldg., Cleveland 14, Ohio.*

Polymer emulsions—Methods of preparing stable, water-based emulsions from Thiokol liquid polymer are outlined in this seven-page brochure. The emulsions are of fine particle size and are potentially suitable as binders and impregnants for wood, paper, textiles, felt, and other water absorptive materials. Additional applications are said to include flexibilization of water-dispersed phenolic, urea, and epoxy resins for coatings and adhesives. The dispersed Thiokol liquid polymer is an organic polysulfide polymer that can, if desired, be cured to a resilient rubber with good oil and solvent resistance, good aging characteristics, impermeability to gases and moisture, and good low-temperature properties. *Thiokol Chemical Corp., 780 N. Clinton Ave., Trenton, N. J.*

Epoxy applications—Uses of epoxy resins for tools, dies, jigs, fixtures, adhesives, laminating, casting, potting, embedding, and encapsulating are outlined in this eight-page booklet. A section on release agents for molds is appended. Data on storage life and handling of these epoxy resin compounds, their working life, mixing, fillers, and cleaning equipment are also included. *Bakelite Co., a Div. of Union Carbide and Carbon Corp., 300 Madison Ave., New York 17, N. Y.*

Multi-V-Drives—A scientific and simplified method for rating V-belts is presented in this 100-page engin-

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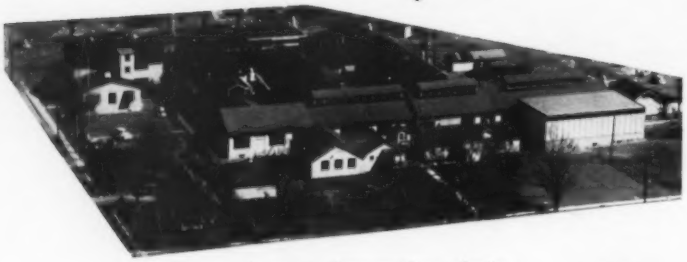

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Specialists in molded cooking utensil components and electrical insulation parts.

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CANASTOTA, NEW YORK

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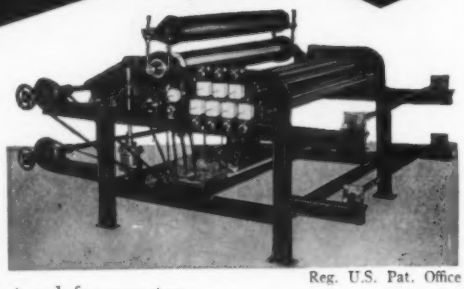
Increased production: the unit is designed for non-stop operation having dual let-off and take-up stands; runs at 6-42 yards per minute

Customers claim up to 35% in yardage without loss of width; chrome and engraved rolls are internally cooled

Superior performance: pressure is infinitely adjustable to suit roll being used; air pneumatic pistons individually controlled



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This Liberty Combined Embossing-Polishing and Laminating, for all gauges of vinyl, has an operating face of 62". Handles widths up to 60".

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Get complete details by writing Liberty Machine Co., Inc., 275 Fourth Ave., Paterson 4, N. J.

eering manual. Each popular 60-cycle motor speed with complete drive selections is shown on separate pages. A table on drive selections contains nearly every possible stock sheave combination and each belt column in the table section has its own series of arc and length correction factors. Service factors for proper duty classification are based on load requirements and hours of service, thus eliminating the general practice of guessing the service factor. Information on products and complete range of stock size sheaves with bore limitations is included. *Worthington Corp., Mechanical Power Transmission Div., Oil City, Pa.*

Glycerine alkyds—How to choose resins for imparting color retention, gloss, drying speed, flexibility, etc., as well as information on processing methods, choice of raw materials, and modifying constituents that influence performance criteria of the finished product is presented in a 20-page booklet entitled "Glycerine Alkyds Tailored to Need." How costs of such resins are related to changes in composition and processing methods is discussed. And a comparison is made between glycerine alkyds and those made from various other polyols. Present and future trends in the manufacture and use of glycerine, alkyds, and methods for their evaluation are also noted. *Glycerine Producers' Association, 295 Madison Ave., New York 17, N. Y.*

Perforated materials—Catalog lists perforated metals, plastics, masonite, etc., giving actual size illustrations of perforated materials, buying information, data on end uses, manufacturing processes, and the like. *Standard Stamping & Perforating Co., 3131 W. 49th Pl., Chicago 32, Ill.*

Teflon rods—Bulletin AD-149 describes the physical properties of the two grades of Teflon available in rod form to fabricators of finished Teflon parts. One grade is made from virgin Teflon powder, the other from reprocessed Teflon. Typical uses, prices, and size information are given. *The Garlock Packing Co. Palmyra, N. Y.*

Pattern, mold, and model machine—This 12-page booklet describes in detail a line of machines that can be

used to produce die and mold cavities; die and mold cores and punches; metal slush molds; vulcanized rubber or metal shells; duplicate metal match plate patterns; duplicate machine master patterns; cast resin masters; tooling and forming dies; and vacuum formed models and samples. The machines, designated Vacurators, are made in four models, varying in size and capacity. All units are equipped with vibrator, vacuum, melting, curing, and storage facilities. Optional overhead infra-red heating and vulcanizing facilities are also available. The brochure gives full step-by-step instructions for producing cavities, cores, punches, etc. Vacurator accessory materials (plasters, putties, waxes, parting compounds, sealing compounds, and undercoats) are also listed. *Guy P. Harvey & Son Corp., Leominster, Mass.*

German technical literature—Catalog of "German Books on Chemical & Cognate Subjects—Published 1950 to 1953" lists German scientific writing in such fields as chemistry (organic, inorganic, colloidal, analytical), chemical technology, mathematics, physics, and others. *Lange, Maxwell & Springer, Inc., 122 E. 55th St., New York 22, N. Y. (Also distributed by Lange, Maxwell & Springer, Ltd., 242 Marylebone Rd., London N.W. 1, England.)*

Styrene boxes — Representative group of stock molded styrene boxes is illustrated in this four-page brochure. These boxes are available in a variety of shapes and sizes, in clear and colored opaque, multicolor sprays, etched, and other effects. Custom design services without mold charge and free packaging consulting service are also covered in the brochure. *The Ira Harmon Co., Inc., 331 Madison Ave., New York 17, N. Y.*

Acetone—Physical and physiological properties, specifications, constant-boiling mixtures, general solvent properties, and resin solubilities of acetone are described in Folder F-8650. Information on performance in nitrocellulose lacquers is given and other uses are described. Acetone is used as a solvent in the plastic, textile, paint and varnish, and pharmaceutical industries. It is also used in dewaxing lubricating

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for extrusion. Special quality for the manufacturer of cables, etc.

GRILON-MONOFILAMENTS
for fishing lines, the manufacture of rope, and for woven technical fabrics.

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oils, as an absorbent for acetylene, and as a chemical raw material. *Carbide and Carbon Chemicals Co., 30 E. 42nd St., New York 17, N. Y.*

Plastics in the home—"Chain Cooking" is a 16-mm. film that demonstrates the correct use of modern food wrapping materials and glass and styrene containers for freezer and refrigerator storage of foods. The film also shows how to decorate a dining alcove with decorative, adhesive-backed vinyl film. For details on availability of film address *Monsanto Chemical Co., Film Distribution Dept., Springfield, Mass.*

Polishing handbook—Digests of 20 technical papers on coated-abrasive grinding and polishing techniques are presented in this 60-page booklet. Subjects covered include: coated-abrasives theory and practice, contour polishing and grinding, inside polishing of recesses and small openings, conversion of polishing jacks to belt usage, contact wheels, part sizing and deburring, swing frame grinding, cylindrical stock grinding, abrasive-belt lubrication, disk grinding problems, tolerance grinding of wide sheets, abrasive strapping techniques, special abrasive cloth shapes and their uses, cutting of spiral-wound abrasive drum covers, and suggestions on cost cutting in production practice. *Behr-Manning Corp., Troy, N. Y.*

Phenolic in rubber—Uses of phenolic resins in the rubber industry, and the resins available for such uses, are briefly outlined in this six-page folder. Applications of phenolics in the rubber field include compounding of hard and semi-hard rubber stocks; solvent adhesives using phenolics with nitrile rubber, natural rubber, and Neoprene; and latices modified with water-soluble or water-emulsifiable resins. *Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y.*

Kel-F in faucet—Corrosion-resistant, stainless steel, fume-tight sanitary faucet with Kel-F sealing rings is described in this bulletin. Data concerning design features, materials of construction, and mechanical and chemical characteristics are given. Properties of Kel-F O-ring seals are listed. *Economy Faucet Co., 12 New York Ave., Newark, N. J.*

Epoxies—Technical Bulletin 6040AT gives information on Hysol 6040 base resin with Hardener AT which provides a liquid epoxy casting system said to have exceptionally long pot life, low viscosity, and qualities usually associated with 100% solid resins. Void-free castings and good penetration are claimed for the formulation. *Houghton Laboratories, Inc., 322 Bush St., Olean, N. Y.*

Silicone—The growing range of product applications of silicone is indicated in this eight-page 1955 reference guide. Some of the applications include cosmetic preparations, dielectric fluids, damping media, lubricants, release agents, adhesives, polishes, textile finishes, insulating materials, resins, foams, molding compounds, and silicone rubber. Reference guide lists typical properties of various grades of silicone material and indicates where they are used. *Dow Corning Corp., Midland, Mich.*

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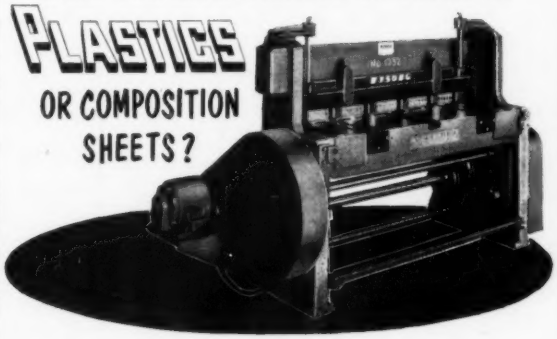

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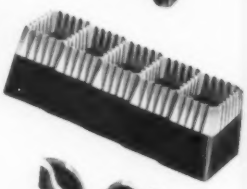

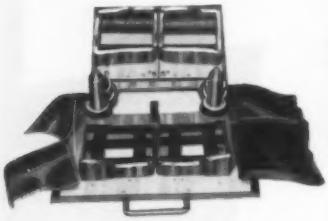

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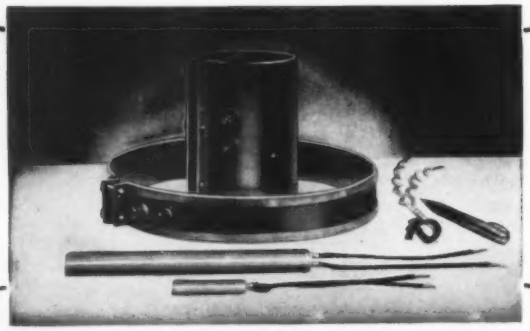

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Production of

FOR the purpose of this report, production is the sum of the quantities of materials produced for consumption in the producing plant for transfer to other plants

PLASTICS AND SYNTHETIC RESIN PRODUCTION IN From Statistics Compiled

Materials	*Total p'd'n. first 11 mos. 1954*	*Total sales first 11 mos. 1954*
CELLULOSE PLASTICS:[a]		
Cellulose acetate and mixed ester		
Sheets, under 0.003 gage	15,973,427	16,103,345
Sheets, 0.003 gage and over	10,945,246	11,627,634
All other sheets, rods, tubes	5,252,637	4,857,344
Molding, extrusion materials	70,092,566	69,280,476
Nitrocellulose sheets, rods, tubes	4,937,270	4,508,078
Other cellulose plastics	5,109,713	4,580,986
PHENOLIC AND OTHER TAR-ACID RESINS:		
Molding materials[a]	163,062,504	153,418,587
Bonding and adhesive resins for:		
Laminating (except plywood)	58,432,444	40,121,562
Coated and bonded abrasives	9,171,611	9,920,210
Friction materials (brake linings, clutch facings, etc.)	14,036,654	13,413,008
Thermal insulation (fiber glass, rock wool)	31,837,452	33,174,230
Plywood	26,830,581	25,729,343
All other bonding and adhesive uses	11,921,745	12,181,589
Protective-coating resins	21,736,519	19,506,325
Resins for all other uses	24,792,348	22,217,948
UREA AND MELAMINE RESINS:		
Textile-treating and textile-coating resins	32,181,725	29,062,266
Paper-treating and paper-coating resins	18,242,339	17,214,565
Bonding and adhesive resins for:		
Plywood	70,943,474	66,375,760
All other bonding and adhesive uses, including laminating	22,414,457	21,151,221
Protective-coating resins	25,366,151	19,219,492
Resins for all other uses, including molding	61,111,591	58,843,084
STYRENE RESINS:		
Molding materials[a]	296,954,865	282,420,089
Protective-coating resins	78,469,559	73,891,084
Resins for all other uses	82,728,509	77,043,970
VINYL RESINS, total[b]	466,856,220	469,378,314
Polyvinyl chloride and copolymer resins (50 percent or more polyvinyl chloride) for:		
Film (resin content)		63,860,510
Sheeting (resin content)		51,904,217
Molding and extrusion (resin content)		132,121,271
Textile and paper treating and coating (resin content)[c]		44,997,396
Flooring (resin content)		31,089,143
Protective coatings (resin content)		21,609,740
All other uses (resin content)		31,179,372
All other vinyl resins for:		
Adhesives (resin content)		25,195,178
All other uses (resin content)		67,168,805
COUMARONE-INDENE AND PETROLEUM POLYMER RESINS	175,833,301	185,200,296
MISCELLANEOUS:		
Molding materials[a, d]	179,754,007	166,942,054
Protective-coating resins[e]	6,478,557	3,417,886
Resins for all other uses[f]	113,528,095	118,249,355

* Dry basis designated unless otherwise specified.
** Partially estimated. † Revised.
[a] Includes fillers, plasticizers, and extenders. [b] Production statistics by uses are not representative, as end use may not be known at the time of manufacture. Therefore, only statistics on total production are given. [c] Includes

(Advertisement)

Plastics Materials

of the same company, and for sale. Sales include only the quantities involved in bona fide sales in which title passes to the purchaser.

POUNDS* FOR OCTOBER AND NOVEMBER 1954 by U. S. Tariff Commission

*October***		*November***	
Production	*Sales*	*Production*	*Sales*
1,370,770	1,344,848	1,440,704	1,604,774
1,166,619	1,153,447	1,130,829	1,206,500
536,689	450,761	524,391	545,807
7,520,059	7,899,755	7,349,725	7,428,040
332,185	299,302	315,947	390,334
415,558	469,693	508,377	386,704
15,050,373	14,596,005	14,723,825	15,540,741
5,944,258	3,852,064	5,428,658	3,931,598
985,573	973,017	1,099,794	1,196,370
1,495,501	1,296,325	1,508,155	1,404,941
3,150,282	3,270,647	3,238,273	3,511,021
3,109,967	2,865,856	3,202,244	3,035,879
1,182,777	1,209,509	944,968	1,033,013
1,993,906	1,526,403	2,015,746	1,669,677
2,138,295	2,422,872	2,747,481	2,463,199
2,899,587	2,849,389	3,202,054	3,199,596
2,433,320	1,872,071	1,633,692	1,697,991
7,123,204	7,071,027	7,403,033	6,577,595
2,476,281	2,013,904	2,816,943	2,580,264
2,613,177	1,827,637	2,491,074	2,020,686
6,199,356	5,801,216	6,225,767	6,470,252
31,592,764	27,700,072	30,229,256	28,099,117
6,763,759	6,341,686	6,922,181	6,925,854
7,603,439	6,453,360	6,265,291	5,969,394
48,969,787	45,381,332	46,532,029	49,018,878
	5,427,106		6,856,700
	4,226,742		4,131,709
	13,456,189		14,057,107
	3,889,659		4,536,696
	3,688,206		4,099,058
	2,198,369		2,130,621
	3,515,048		3,653,266
	2,215,227		2,235,461
	6,764,786		7,318,260
†19,141,121	18,239,876	18,670,357	18,094,881
19,573,015	16,383,281	22,196,116	17,523,028
724,234	330,315	255,249	232,959
13,097,813	13,522,068	10,999,496	12,821,841

data for spreader and calendering-type resins. [d] Includes data for acrylic, polyethylene, nylon, and other molding materials. * Includes data for epichlorohydrin, acrylic, polyester, silicone, and other protective-coating resins. [f] Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.

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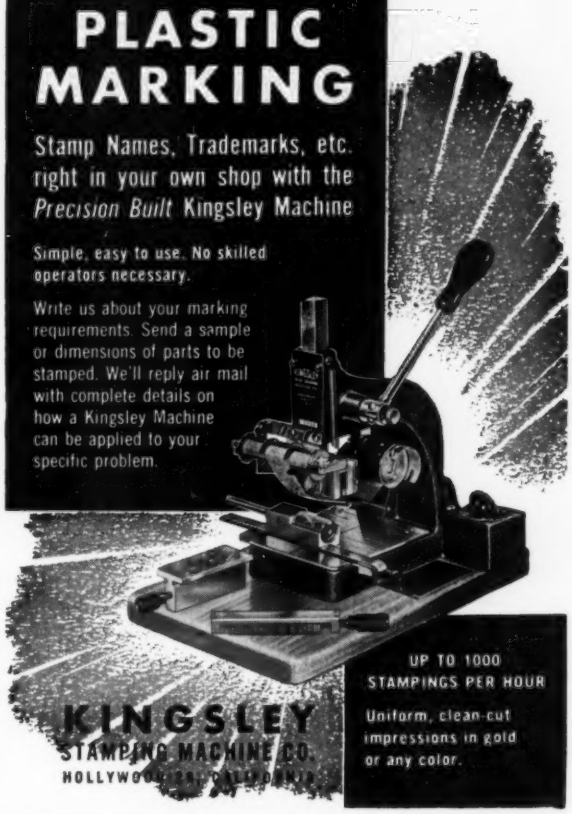

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Packaging Div., Ever Ready Label, 117D East 30th St., New York 14, N. Y., MUrray Hill 6-1220. Plant: Belleville 6, N. J., WHitehall 3-5454.

New national officers of The Society of Plastic Engineers for 1955, from left to right, are J. W. Lindau III, secretary; Frank W. Reinhart, president; John W. LaBelle, director at large; Ernest P. Moslo, vice president; and H. S. Nathan, treasurer

New S.P.E. Officers

THE 11th National Conference of The Society of Plastic Engineers, held in Atlantic City January 19 through 21, 1955, was by far the largest and most successful held to date. Registration was approximately 1800, or about 60% greater than at the last conference which was held in Toronto.

Moderators for the panel discussions were: *Fluorocarbon Panel*, George Koch, Oak Engineering Co.; *Controls Panel*, Saul Blitz, Tico Plastics, Inc.; *Tool Steel Panel*, Islyn Thomas, Newark Die Co.; *Education Panel*, Richard B. Bishop, Foster-Grant Co.; *Reinforced Plastics Panel*, J. M. Scott, Winner Mfg. Co.; *Polyethylene Panel*, W. F. Oelman, Standard Molding Corp.; *Injection Molding Panel*, E. W. Cronin, Hercules Powder Co.; and *Research Panel*, Bryce Maxwell, Princeton University.

Moderators of other meetings were: G. W. Martin, Noma Lites, Inc.; R. H. Bruce, Bakelite Co.; A. Lightbody, Naval Ordnance Lab.; M. J. Petretti, Camfield Fiberglas Plastics; Stanley Bindman, Jamison Plastics Co.; Frank W. Reinhart, National Bureau of Standards.

At the National Council Meeting, held just prior to the conference, the following national officers were elected:

President, Frank W. Reinhart, chief of Organic Plastics Section of the National Bureau of Standards; Vice President, Ernest P. Moslo, president, Moslo Machinery Co.; Secretary, Professor J. W. Lindau III, University of South Carolina; Treasurer, H. S. Nathan, president, Atlas Plastics Co.; Director at Large, John W. LaBelle, Foster-Grant Co.

The National Council members elected for 1955 for the various sections of S.P.E. are as follows:

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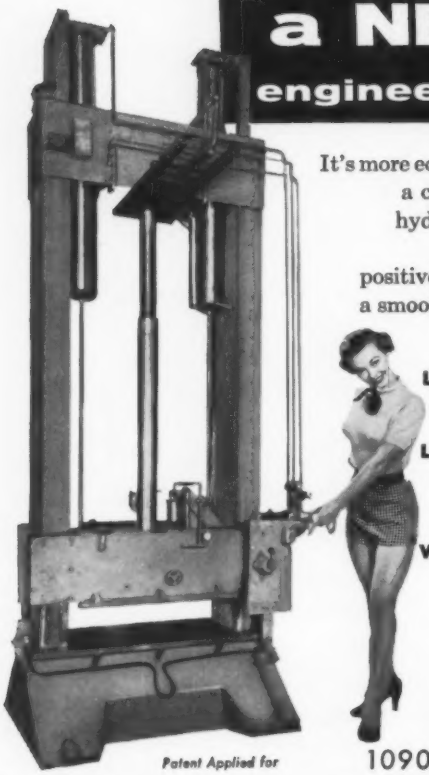

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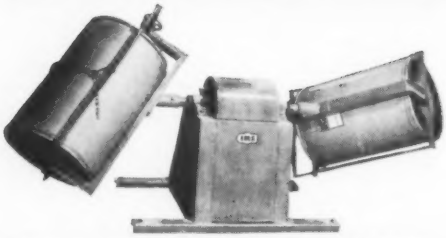

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Bulletin 194—S gives details of these instruments. They help save money and make better plastics.

Acrylic Cabinet

DESIGNED originally as a dealer demonstration aid to illustrate the advantages of a printed circuit chassis, a combination clock-radio with an acrylic cabinet, produced by Hallicrafters Co., Chicago, Ill., created so much interest that it has been placed in limited commercial production.

The attractive "peek-a-boo" case is fabricated of ¼ in. thick transparent acrylic sheet so that the internal clock-radio mechanism and the printed circuit assembly are clearly visible to the observer. When used as a dealer aid, the transparent cabinet serves to dramatize the compact finished assembly made possible by soldering connections directly onto the circuit lines etched into the copper face of the copper-phenolic laminate panel; for the consumer model, the "see-through" cabinet was a good attention getter and proved to have definite eye-appeal.

To form the top, front, and bottom of the case, a single piece of acrylic sheeting is scored, heated, and bent to exact right angles. The ends and back of the housing are fabricated separately and then assembled to the other three sides with self-tapping screws. The numerous sound and ventilation openings required in the ends and back of the cabinet are produced by the use of a multiple head drill.

CREDITS: Hallicrafters cabinet fabricated by Associated Plastic Fabricators. Chicago, Ill., using Plexiglas acrylic sheet supplied by Rohm & Haas Co., Philadelphia, Pa.

Handsome cabinet for clock-radio is fabricated of transparent acrylic sheet

Simplify your

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FOR ALL HYDRAULIC AND OTHER LOW PRESSURE CIRCULATING SYSTEMS

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Available in sump and line types, in capacities from 5 to 100 G.P.M. Monel mesh sizes range from coarse 30 to fine 200.

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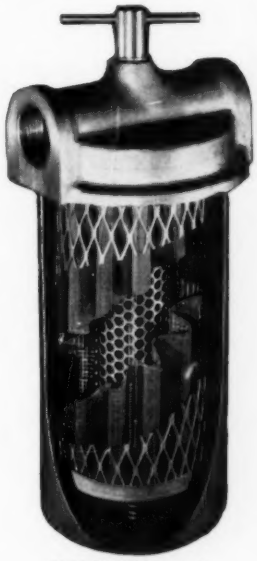
Marvel's most recent development is a filter for the efficient filtration of all types of non-flammable hydraulic fluids.



LINE TYPE (Cutaway)

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Both sump and line type filters have been adapted for use in all water filtering applications. No changes have been made in the basic, Balanced Synclinal Design.

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- ☐ Catalog #300—For WATER
- ☐ Data on filters for Non-flammable hydraulic fluids.

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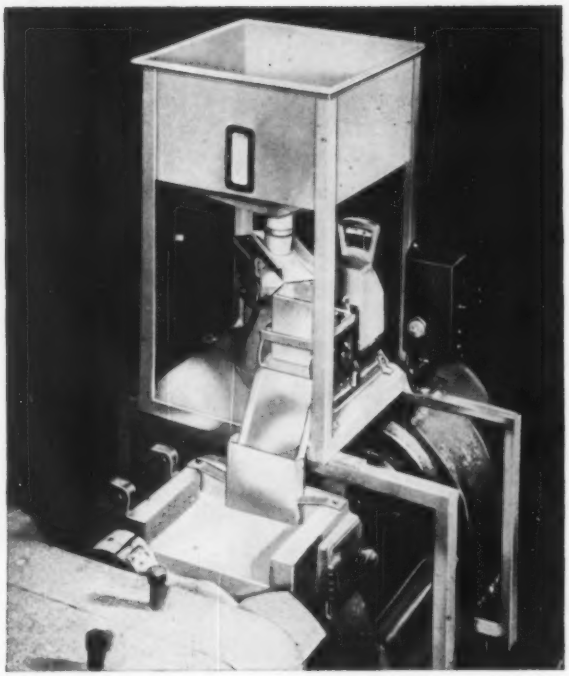

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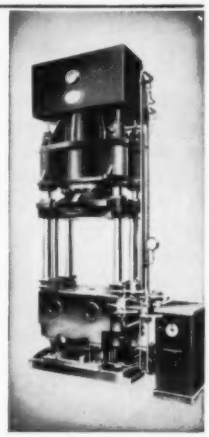
Illustrated is model No. 984, 350 ton self-contained press with automatic push button time cycle control. This press embodies its own pump unit and can be supplied with either electric or steam heated platens.



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Water header pipe, before being repaired with polyester-fibrous glass laminate overwrap, had eroded completely through in some areas and was badly rusted in others

Pipe Repaired with Polyester-Fibrous Glass

IN THE economical maintenance of plant equipment, the use of polyester-fibrous glass laminate is playing an increasingly important role. A recent example of the versatility of the material for such purposes was the repair job done on a water header at the Bishop, Texas, plant of Celanese Corp. of America.

Approximately 40 lineal feet of the original header pipe had eroded, with large holes in some areas and the balance of the pipe rusted almost paper thin. There were about 20 holes below the water level of the pipe, which normally runs half full.

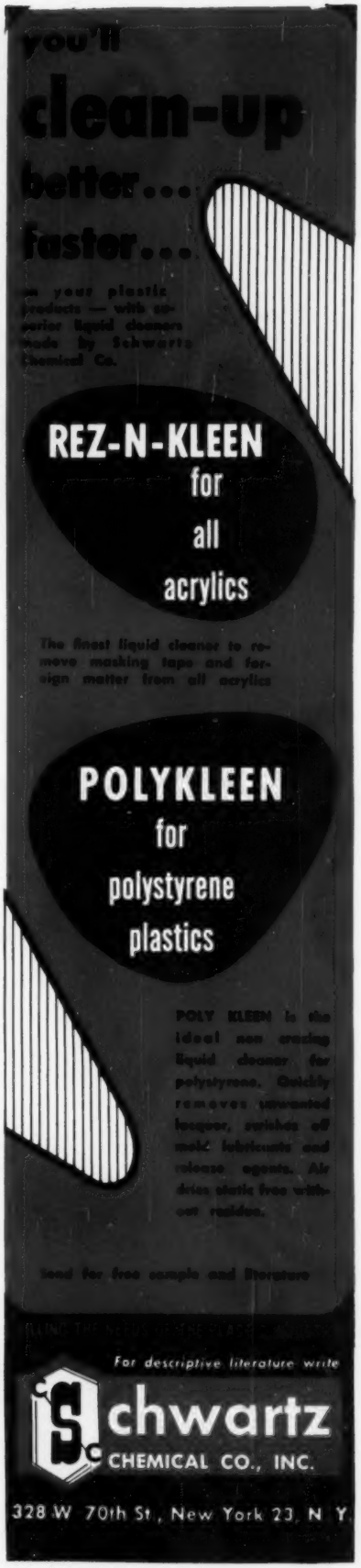
Laminate used to repair eroded pipe is strong enough to support man's weight

The repair procedure used was as simple as it was effective. First, scale was knocked off and two plies of glass cloth, saturated with a self-curing polyester resin, were applied over the large holes. Leaks were then plugged and two additional plies of resin-saturated glass cloth were wrapped around the entire rusted area of the pipe, one at a time.

Just 30 gallons of resin were required and total material costs amounted to only $137.88. It was, of course, unnecessary to remove the multiple connections or the pipe itself, thereby saving the many costly man-hours that would be required if the section were replaced.

The polyester-fibrous glass reinforcement has ample strength to carry the weight of a man standing over the completely rusted-through section of the header. The laminate will not rust or rot and its moisture absorption is less than 0.5 percent. In the event that accidental rupture of the covered pipe should occur, however, repairs could be made by applying additional laminate to the damaged areas.

CREDITS: MR-28C polyester resin supplied by Celanese Corp. of America.



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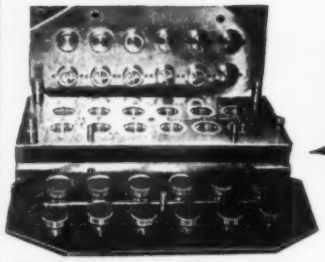

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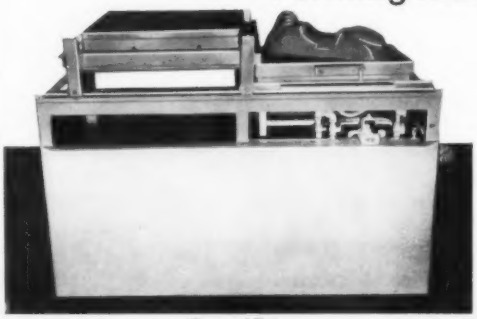

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Polyethylene Tube

PASTE-TYPE solder now joins the list of products that can be effectively packaged in easy-to-use polyethylene tubes (see "New Prospects for Polyethylene Containers," MODERN PLASTICS, *32*, p. 94, Dec. 1954). The attractive container, which will not dent, crack, or tear, even under rugged shipping or use conditions, brings functional advantages, protection of contents, and high merchandising appeal to the solder product.

The head of the polyethylene tube has a long delivery nozzle which permits pinpoint application of the solder to the desired spot. A gentle squeeze on the tube extrudes the solder paste in easy-to-apply fashion and, because of the resilience of polyethylene, excess solder is snuffed back into the tube after each squeeze, keeping the nozzle clear of paste. After applying the solder, all that is necessary to complete the job is to heat adjacent surfaces. In many instances, a match will provide all the heat that is necessary. The solder is 50/50 tin-lead, mixed with flux in paste form.

One of the features of the polyethylene tubular container is the clear, legible printing and the high-quality color register. On the tube for packaging solder is used a color combination of blue and orange to give an attractive appearance which makes the container suitable for displays aimed at impulse sales in hardware stores and other outlets.

CREDITS: Swif solder is packaged by Hercules Chemical Co., Inc., New York, N.Y., in tubes supplied by Bradley Container Corp., Maynard, Mass.

Solder-paste is applied to exact spot desired from nozzle of polyethylene tube

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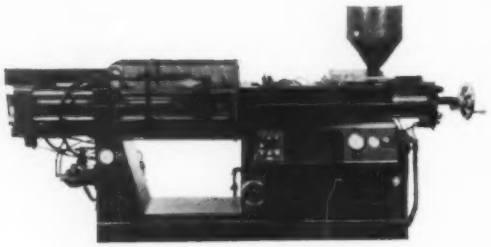

This is a high speed injection molding machine for automatic, single cycle or manual operation. Features low pressure closing, adjustable clamp stroke and cushion—both ends. All parts easily accessible for operation and maintenance.
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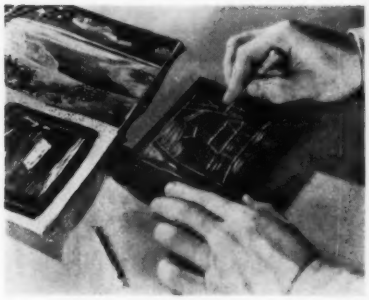


Line drawing to be reproduced is scratched into polyester-coated block

Plastic Woodcuts

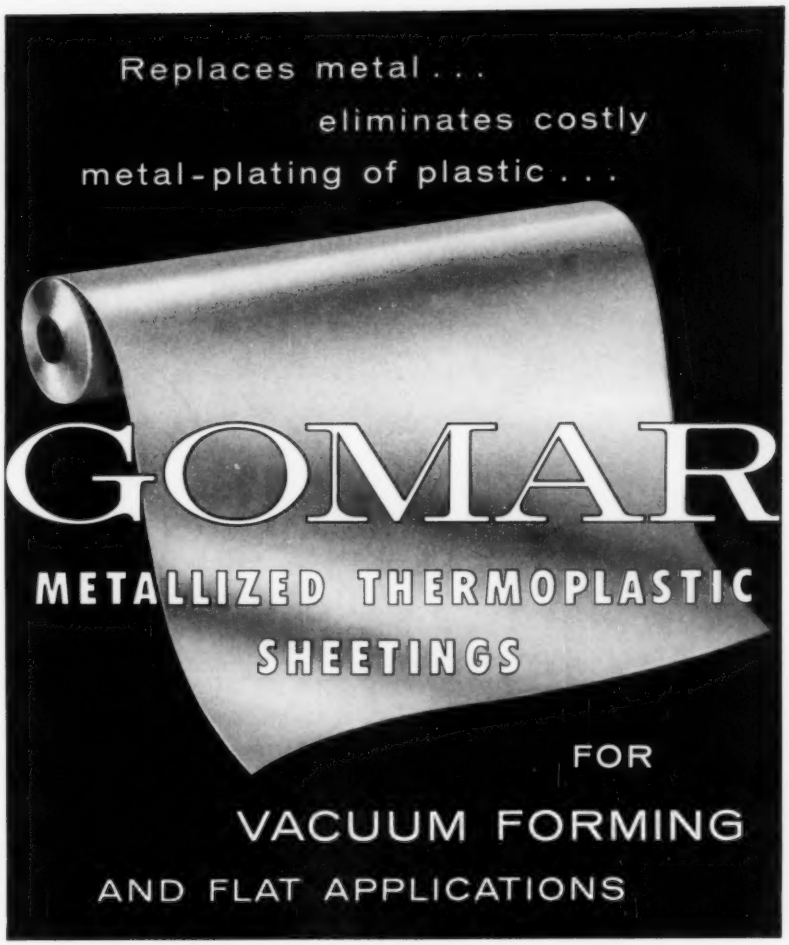
WOODCUT prints, made by a completely new method that should appeal both to the amateur and to the professional craftsman, are produced on plaster blocks backed-up with fibrous glass mat and coated with polyester resin.

Available to the consumer as part of a new hobby kit for making such prints, the coated plaster blocks are claimed by the manufacturer to be not only much lower in cost than the rare, end-grain woods required for conventional woodcuts but much easier to work with than either wood or linoleum. All that is needed to carve the polyester-coated plaster block, using normal writing techniques and pressure, is a simple engraver's hand tool. Because of the smooth surface of the polyester coating, even lightly scratched lines are adequate for the production of clear prints.

As a guide to the craftsman working out a pattern on the blocks, the polyester resin coating is pigmented. When the block is carved, therefore, the lighter-colored base shows up in the scratched areas in sharp contrast to the darker polyester surface of the block.

When reproducing a drawing carved into the coated block, the block is first inked with a hand roller also included in the kit. As many prints as desired can then be pulled directly from the inked block, using only hand pressure. Because the polyester surface of the block absorbs no ink, the inked drawing is fully transferred in detail from block to paper.

CREDITS: The hobby kit is made by Bassons Industries Corp., Bronx, N. Y., using polyester resins supplied by Bakelite Co.



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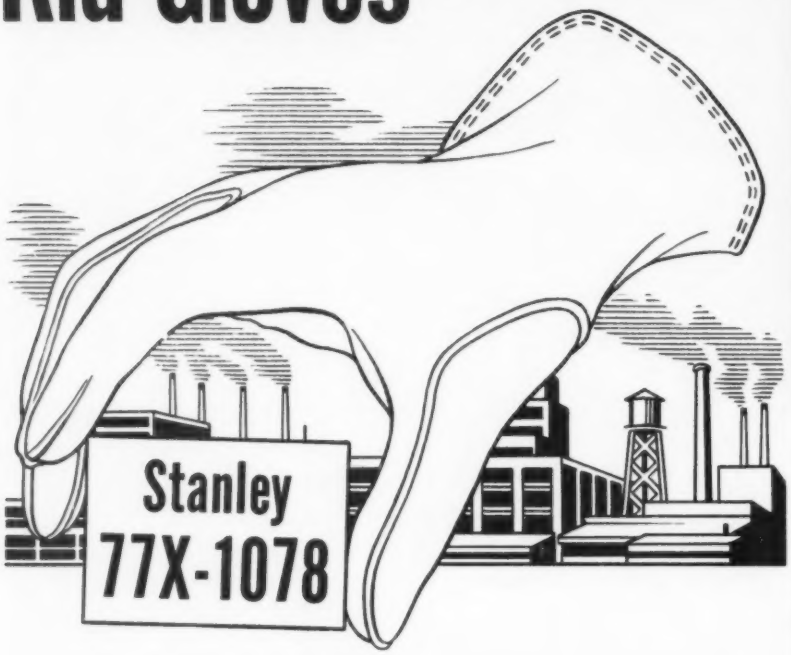

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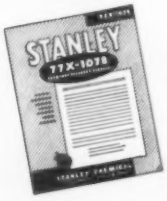
When materials handling means handling with care it will pay you to see that your racks, tote baskets, or other metal containers are coated with Stanley 77X-1078, the resilient orange plastisol that safeguards your product from damage. In cleaning and finishing operations the high resistance of 77X-1078, to inorganic acids, salts, and alkalis, to organic materials — particularly trichlorethylene and perchlorethylene — and to most plating solutions, is your assurance of surface protection that lasts. And the surface of 77X-1078 is just hard and slick enough to promote rapid drain-off and to minimize carry-over. The new Stanley bulletin shown below contains full details about application of 77X-1078 and the test results that proved its chemical resistance. Copies are available on request.



Write today for the new bulletin on 77X-1078 to the Stanley Chemical Company, 71 Berlin Street, East Berlin, Connecticut.

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Rugged nozzle of vacuum cleaner is molded of general-purpose phenolic

Vacuum Cleaner

BY INCORPORATING molded plastics attachments and various accessory parts in the design of a new home vacuum cleaner, the manufacturer claims to have kept the weight of the unit down to 9 lb., while, at the same time, improving its performance so that it functions as efficiently as comparable models three or four times as heavy.

The rugged, attractive housings, nozzles, and elbows for two of the standard cleaner attachments—the hair dryer and the demother—are both molded of general-purpose phenolic. In addition, because of the heating unit which is incorporated in the hair dryer, a small wheel and disk inside the dryer housing are also molded of phenolic to take advantage of the material's resistance to heat.

Other plastics components include a molded flexible polyethylene impeller housing cover and body located inside the cleaner and a precision molded nylon signal device which is fastened to the outside of the unit to indicate to the user when the dust bag is filled and has to be emptied out.

CREDITS: Plastics accessories are molded for Ultimo Mfg. Co., Orange, N. J., by Bolta Products, Div. of The General Tire and Rubber Co., Lawrence, Mass. Phenolic is supplied by Durez Plastics and Chemicals, Inc., and Bakelite Co.; polyethylene is supplied by Bakelite Co.; and nylon by E. I. du Pont de Nemours and Co., Inc.

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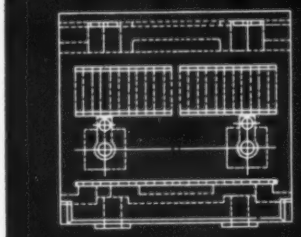
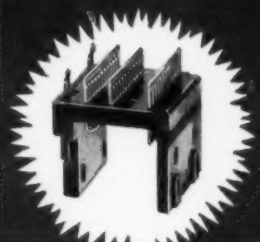


Custom Molding



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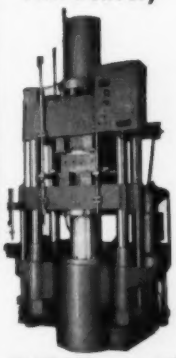

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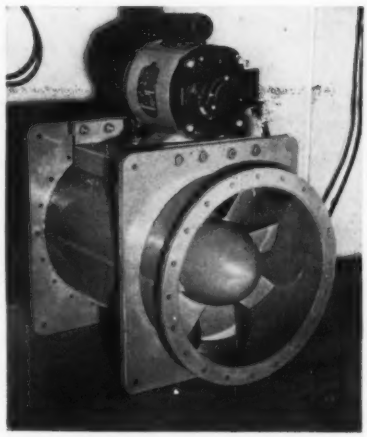

Vinyl body protects blower parts against corrosion; blades are also vinyl

Vinyl Blower

DRIVE shaft, pulley, belts, and bearings of an industrial blower for handling corrosive air, fumes, and gases are completely encased in a cylindrical housing fabricated of vinyl to protect these components against the effects of corrosive atmospheres.

Even the impeller blades, which are mounted at the end of the drive shaft in the front of the housing, are fabricated of vinyl, thus insuring that they will never corrode. Each blade is fabricated separately, inserted into slots in a disk behind the aerodynamically balanced spinner cap, and welded securely into place. According to the manufacturer of the blower, the ease and economy with which these blades could be fabricated and assembled into the finished unit played a major role in the final decision to use vinyl for the unit.

The ¾-hp., 3-phase motor—single-phase motors are available on request—is mounted on a steel pedestal fastened to the top of the lightweight, heavy-duty vinyl housing. If required by the presence of highly corrosive atmospheres, a protective coating can be applied to the steel pedestal.

The blower is manufactured in a wide range of sizes, from 14 in. up, and is designed so that it can be installed either horizontally or vertically.

CREDITS: Blower is manufactured and marketed by Industrial Plastic Fabricators, Inc., Norwood, Mass.

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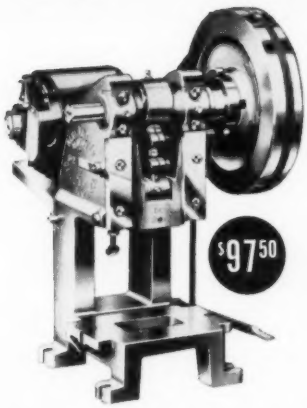

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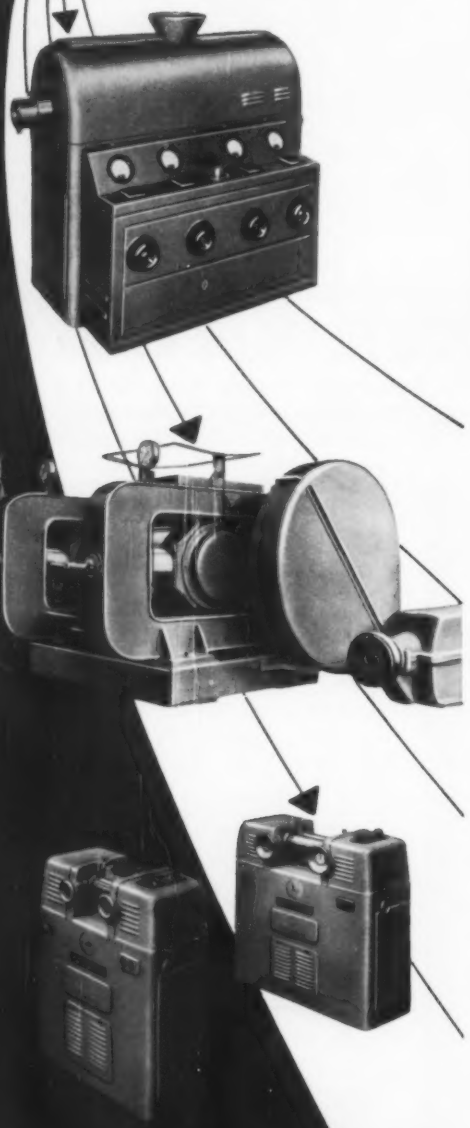

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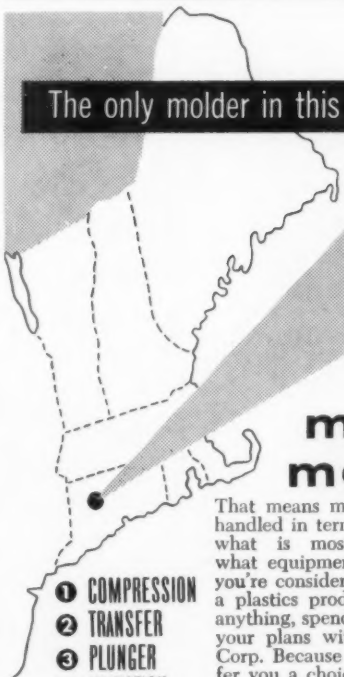

5
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Tools for Irradiation

(*From pp. 85-88*)

ried out, and this logic proved correct. Output is currently in excess of 35,000,000 r./min. at the usual treatment distance of 4 in., and is being further improved.

Handling and Irradiation of Materials—In material of the density of water, electrons are completely absorbed at a depth of 0.2 inch. Irradiation can be made more uniform by irradiating appropriate thicknesses of material from two sides. The penetration of electrons is directly proportionate to the voltage applied in the generator.

A number of systems have been used for safely delivering materials to the electron beam, and investigation will undoubtedly suggest others. A conveyor belt has been used to transport polyethylene bottles through the beam. Plastic tape and strip are found to "cure" most efficiently when rolled or unrolled from a reel located within the beam.

Irradiation of plastics materials to improve properties generally requires much higher dosages than those used in other applications, such as food sterilization. Treatments for plastics in the range of 10,000,000 to 20,000,000 rep (see glossary, p. 88) are not uncommon, although lower and higher doses can be used in specific cases to produce desired changes.

Costs for the large doses used in chemical treatment and modification of plastics have been found to be in the range of a few cents per pound.

Past experience in electron beam irradiation is by no means limited to treatment of solid plastics materials. Oils and paraffins sufficiently irradiated will become rubbery solids. Irradiation will turn monomers into solids. Electrons will take part in other chemical reactions in the vapor or gaseous phase, producing new chemical compounds.

In some cases where irradiation dosages are so high that a process does not seem economically feasible, there is the possibility of combining irradiation treatment with conventional chemical reactions to produce a desired end product. The electrons then would serve as a catalyst.

The varied requirements of individual electron-beam-generator installations make it impossible to

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pinpoint the financial investment involved, but this information can readily be determined by consultation with representatives of the manufacturers. General Electric's X-ray Dept. offers a comprehensive rental plan based on a fixed monthly charge, relieving the user of concern over installation, maintenance, parts, insurance, taxes, etc.

Capacitron Irradiation—The Capacitron, produced by Electronized Chemicals Corp., New York, is a machine that produces electron bursts of exceedingly short duration but very high intensity. This is accomplished by charging a number of capacitors in parallel, by means of a rectifier unit, and allowing the capacitors to discharge in series across gaps that spark over at predetermined voltages. Both capacitors and discharge tubes can be immersed in oil tanks, and conveyor belts can use underground or other shielding. Where a short time (microseconds) jolt of electrons might be required, this machine should prove useful.

Van de Graaff Accelerators—For the production of electrons, as well as other types of beams, the Van de Graaff accelerator made by High Voltage Engineering Corp., Cambridge, Mass., is a well-known machine.

An electric charge is sprayed on a high speed belt and conveyed to a large high-voltage terminal which is insulated from the accelerator shell by a gas under high pressure. Electrons or other charged particles are produced and accelerated by the high voltage gradient down an evacuated tube, to bombard whatever is beneath the beam outlet. Prices run from $30,000 for a 1-m.e.v. accelerator to $110,000 for a 3-m.e.v. unit, plus, in each case, auxiliary equipment. Figure 6 shows such a unit.

High Voltage Engineering Corp. maintains a complete electron irradiation facility as a rental service, built around a 2-m.e.v. Van de Graaff unit.

Linear Accelerators—A relatively new development in electron accelerators is the linear or indirect type, which carries the electrons on waves of radar frequency energy, kicking them along by local electric fields in a wave guide. It is expected that the high-voltage problem will thus be overcome and that linear accelerators with energies of up to 600-m.e.v. may be possible. High Voltage Engineering Corp. is currently building a machine of this type.

A projected design by Applied Radiation Corp., Walnut Creek, Calif., is expected to give a 6-m.e.v. output for 10 microsecond pulses with a repetition rate of 360 per second.

• • •

All these machines for irradiation must be studied by management as well as technical and engineering departments in plastics concerns, from the standpoints of original cost, accessories costs (shielding, conveying, etc.), kw.-hr. efficiency, rate of output, and maintenance costs.

It is claimed that for the purposes of cross-linking polymer molecules, the machines are much more efficient than isotope sources. A Van de Graaff accelerator, for example, will irradiate polyethylene tape with better than 90% efficiency, while no efficiency figures for isotope sources for this purpose have been reported higher than 30 percent.—END

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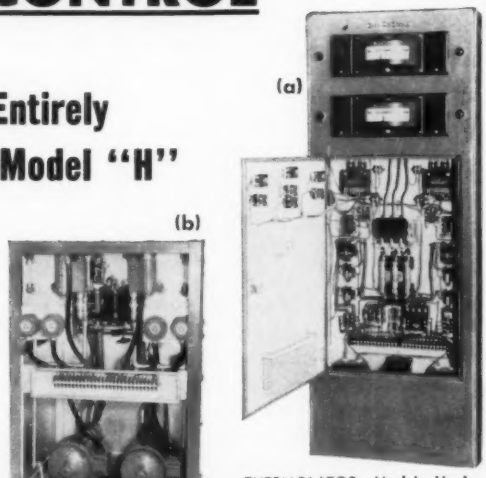
- **Unequalled Mold Temperature Control Performance**
  Assured by High Velocity-High Capacity circulation, with exclusive patented control features.

(a)

(b)



THERMOLATOR Model H includes Control Cabinet (a); and Operating Unit (b) for permanent installation.

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R/A

Isotopes

(*From pp.* 89-90)

ited, and not wide enough to meet all requirements. However, a second method of isotope production exists, by which isotopes can be produced in almost unlimited varieties.

This method consists of exposing a quantity of stable material (a pure element, a penny, a piece of steel, etc.) to neutron bombardment in an atomic reactor. Actually, two techniques are possible to thus radioactivate stable elements: neutron absorption and transmutation.

Neutron Absorption—In this reaction stable atoms absorb a neutron, increasing their mass by one, and begin to radiate. Radiation continues until the atoms return to a stable state. The practical drawback of this process is that both the stable isotope and its radioisotope are atoms of the same element, making chemical separation impossible.

Transmutation—A far superior reaction involves the transmutation of elements. In this method, a stable atom, subjected to neutron bombardment, not only captures a neutron, but at the same time has one of its protons knocked out. This transmutes some of the stable atoms into radioactive isotopes of the element with the next lower atomic weight. With isotopes of two different elements present, one stable and one radioactive, a chemical separation process results in a quantity of pure radioisotopes.

Radiocarbon, for example, can be produced through the neutron absorption process in which C^{13} (normal stable carbon) is changed to C^{14}; however, C^{14} cannot be chemically separated from C^{13}.

In a transmutation reaction, on the other hand, with normal nitrogen (N^{14}) as the target element, the situation changes. Upon bombardment, the nitrogen atoms, absorbing one neutron and losing one proton, become transmuted to carbon-14, which can be separated chemically from normal nitrogen to isolate pure, high-activity, isotopes.

Where to Get Isotopes

Reactors at Oak Ridge, Brookhaven, and Idaho are available for making samples of materials radioactive. Because of uncertainties in the patent law situation, these

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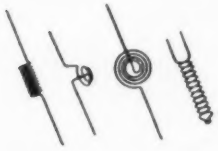

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samples are generally sent to the radiation facilities unidentified, accompanied by a guarantee that they will not harm the reactor.

All requests for radioisotopes must have clearance from the U. S. Atomic Energy Commission. For the procurement of tagged chemicals, the Commission's catalog of isotopes should be consulted to determine if a desired chemical is obtainable directly from Oak Ridge. If the AEC does not distribute the desired compound, companies listed in Table II should be queried.

Uses for Isotopes

With relative availability of large quantities and varieties of radioisotopes today, new ways of using them are being discovered at an increasing rate and a pattern of activity is beginning to emerge. Some of the areas in which isotopes have been tested and applied with varying degrees of success are as follows:

Irradiation of Monomer—A fair but by no means conclusive amount of work has been done on the initiation of polymerization by monomer irradiation, using cobalt-60 for gamma initiation and strontium-90 for beta initiation. Naturally occurring radioisotopes — radium, radon — also have been used for this.

Evidence to date indicates that radiation-initiated polymerization permits low-temperature polymerization, polymerization in the solid state, and polymerization without danger of contamination from catalyst fragments. There is also evidence that radiation-initiated polymers will have physical characteristics differing from those obtained by conventional methods. Improved emulsion techniques, using radiation catalysis, have also been reported. However, the mechanisms underlying these reactions have not yet been fully clarified.

Polymer Irradiation—It has been shown that polymers as a rule react in one of two ways to irradiation: they cross-link or they degrade. Polymers that have been reported to cross-link include polystyrene, polyesters, polyacrylic esters, nylon, polyvinyl chloride, polyethylene, and others. Plastics that have been found to degrade under the influence of irradiation include polymethyl methacrylate, Teflon, Kel-F, cellulosics, polyisobutylene, and others.

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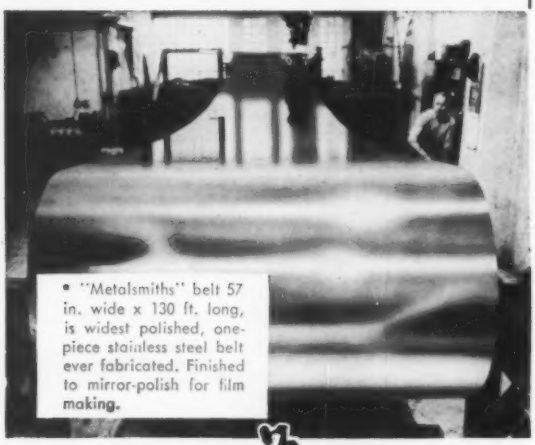

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plastic into a thermoset with a disintegration temperature considerably above the melting point of the thermoplastic. However, while heat stability is improved, evidence has been found in some cases that indicates impairment of other properties such as tensile strength, elongation, etc.

The most commonly used isotope source for polymer irradiation by gamma rays is cobalt-60. This source is available at Brookhaven, Oak Ridge, Argonne, Michigan, Yale, Stanford, Columbia, M.I.T., General Electric, and the Naval Research Lab.

Isotopes separated from fission products, such as Cs^{137}, are also starting to come into use for this application and irradiation of polymer is being done on a fairly large scale with electron generators.

Facilities for irradiating material with gamma rays from an isotope source represent installations of major proportions. They require well-trained operating personnel and must be equipped with safeguards for the complete protection of the people working in them. They are not the type of set-up a small operator can lightly contemplate incorporating in his plant.

Instrumentation—One of the most successful uses of isotopes is in the development of instruments for non-destructive testing.

Cobalt-60 is used as a radiography source for the non-destructive inspection of material for flaws. Before it became available, X-rays and radium sources were used for this purpose; but their cost, especially to the occasional user, has been prohibitive.

Strontium-90 (half-life 25 years) is used extensively as a radiation source in beta gages, discussed in detail in the article starting on p. 104.

Tracing and Research

The use of radioisotopes as tracer elements, first developed in biology and medicine, is being increasingly investigated by the plastics industry. Research ingenuity in this field has yielded spectacular results.

For example, isotopes were used as tracers in studies of automobile tire tread wear (B. F. Goodrich) and the technique may be easily extendable to plastics wear studies as well. In the tire study, Geiger coun-

ter measurements were performed on tracks made by tires molded of materials having radioisotope components. The resultant reading gave an indication of wear. The advantage of applying isotopes in these tests was that significant results could be obtained in a period much shorter than that required by conventional methods.

Another wear study, made with the use of isotopes, involved mold erosion (G-E). In this case, a sprue bushing was made radioactive and Geiger counter readings were taken of moldings of material that had passed through the irradiated sprue bushing. (See "What Causes Mold Erosion?" MODERN PLASTICS, *32*, 131, Sept. 1954.)

Hydrogen-3 (tritium) has been used to measure water vapor penetration into attached protective coatings (Batelle Memorial Inst.).

Studies in molecular migration, of special interest to the plastics and rubber fields, have been made by tracer techniques (The Goodyear Tire and Rubber Co.), using C^{14} and S^{35}.

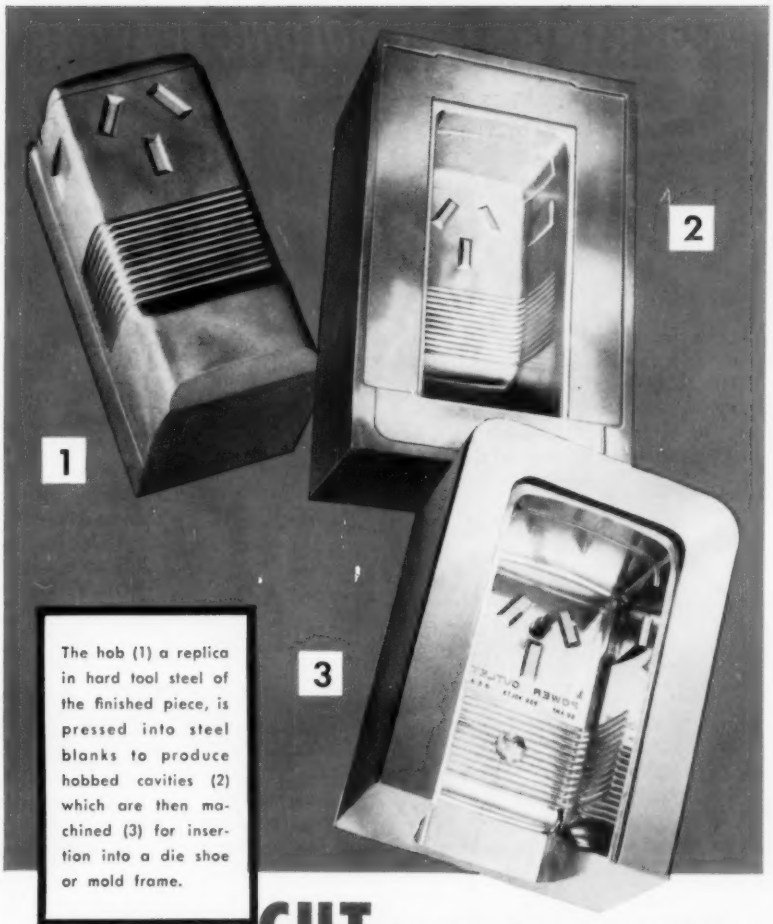
Isotopes have also been used in tracer studies of permanency of plasticizers and plasticizer distribution in vinyl formulations.

Tagged Compounds

A list of suppliers of isotope labeled chemicals appears in Table II, p. 90. A detailed listing of the labeled compounds offered by these various suppliers, for both organic and inorganic chemicals, has been published in *Isotopics*, Vol. I, No. 4, which is available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at a cost of 25 cents. A list of isotopes of special interest to the plastics industry appears in "Catalog and Price List, Isotopes," Oak Ridge National Laboratory, Oak Ridge, Tenn. ($1.00).

Prospects

Plastics have always been known as the wonder chemicals. Now that they have joined hands with nuclear energy, vast vistas for future development have opened up. While there are definite limitations to the application of that energy in the plastics field, there is promise of new and better molding materials, improved processing methods, and better end products.—END



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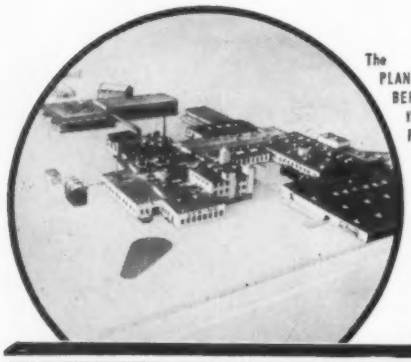

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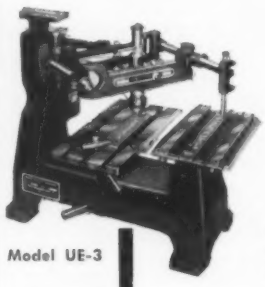

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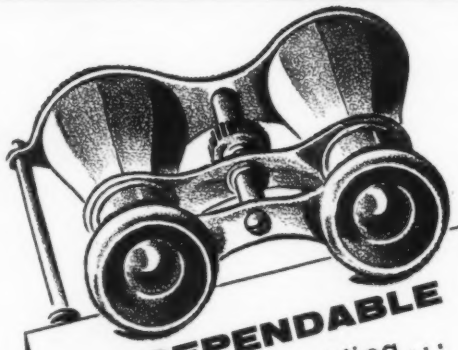

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Radioisotope Lab

(*From pp. 91-93*)

where the phosphor and the sample are mixed in solution, is available. Hard beta radiation can almost always be most conveniently detected with a thin window Geiger counter. This is such an efficient technique that it is usually best to count the beta radiation from a sample even if it also emits gamma radiation. If the sample is very active, a proportional counter or a scintillation counter with a beta sensitive crystal such as Stilbene has to be used. Of these two, the scintillation counter is generally the simpler instrument.

Gamma radiation cannot be measured with any considerable efficiency by means of a normal Geiger or proportional counter. Special Geiger counters are available which have an efficiency of up to 5% depending on the energy of the gamma rays, while scintillation counters with sodium iodide (thallium-activated) crystals have about 10 times that much efficiency. For both types of detectors, counters are available which will accept liquid or bulky samples inside a central well.

Each detector should be provided with background shield which also serves as a means of inserting samples in a reproducible manner. For the sake of reproducibility and intercomparison, standard sample holders and reference sources are also required.

As previously mentioned, these detectors are connected to a counting instrument. Such an instrument must have certain basic features and can have a considerable number of options. It must supply the high voltage required for the detector, it must have a circuit for receiving the pulses from the detector, and it must have a means of presenting the data obtained from the detector. If the detector is a proportional counter or a scintillation counter without built-in pre-amplifier, the counting instrument must also contain an amplifier, or an intermediate amplifier must be used.

In the simplest case the counting instrument, if it is a scaler, has an electronic scaling factor, usually at least a factor of 100, followed by an electromagnetic register with provisions for an external timer to be started and stopped simultaneously with the count. In the most complex case the scaler has a scaling factor of at least 1000 with provisions for preset count on the scales and on the register, a built-in timer with preset provisions, push button controls, built-in or plug-in amplifier, built-in or plug-in ratemeter, built-in or plug-in pulse height discriminator, provisions for operating automatic equipment, etc. Between these limits the most generally useful laboratory instrument has a scaling factor of at least 1000 with a total count capacity of at least 10,000 and with preset count provisions, a built-in interval timer, and provisions for operating automatic equipment.

A ratemeter, though never quite as precise as a scaler at low counting rates, is frequently sufficiently accurate for many experiments and has the advantage that the count rate information can be read directly from the meter or from an attached graphic recorder. For laboratory assay work it should have four to six scales with the highest range being at least 25,000 counts per minute, and it should have a device of integrating time constants.

The above information on counting equipment is summarized in Tables II and III. However, while the Tables indicate a desirable combination of instruments for a particular type of measurement, a new laboratory would in most cases buy several different detectors.

Over-All Cost

From the foregoing discussion and the Tables it can be seen that the cost of equipment and instruments needed for a well-rounded basic radioisotope laboratory is likely to be in the range of $1000 to $5000. The cost of the isotopes can run from a few hundred dollars to a few thousand dollars per year, depending on the form in which the material is purchased. Beyond these expenses there remains only the cost of training personnel. A standard one month basic course is given by the Oak Ridge Institute of Nuclear Studies for a nominal fee of $25, and specialized individual training courses of one and two week duration are available at the Boston, Mass., and Richmond, Calif. laboratories of Tracerlab, Inc., for about $500.—END

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Polymerization

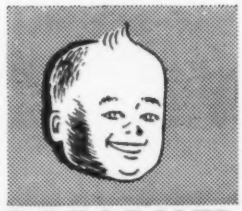
(*From pp.* 94-97)

ene to polyethylene per day. If a polymerization process is operated 300 days per year, the output will be 3 lb./year. Taking the cost of the radiation source at $0.10 per curie, as assumed above, it is seen that a one-dollar radiation source can produce 3 lb. of polyethylene per year. At the end of the year we would have something less than 10 curies of radiation, the drop depending upon the half-life of the particular source used. During the year we would have a capital investment of $1.00 tied up so that it could not be earning interest elsewhere. If replacement and interest charges are 30% of investment, radiation cost alone is 10¢/lb. of polyethylene.

In the radiation polymerization the process may be carried out at room temperature and 70 atm. pressure, while the conventional process requires much higher temperatures and high pressures as previously mentioned. The mechanical equipment cost for the radiation process is simpler and lighter and, therefore, cheaper than for the conventional process. If the saving in equipment is enough to pay for the radiation source and its housing, there may well be an economical application of radiation in this process. Of course, the assumption is being made that the products from the two processes are comparable. If the products are different in molecular weight, cross-linking, and resultant physical properties, the comparison must be made with other comparable polymers.

Conclusions

The formation of high polymers by polymerization of some alkenes in the presence of gamma irradiation offers promise of plastics with properties which may be more satisfactory than those made by usual procedures and in some cases, at least, at favorable costs. However, the irradiation of high polymers may materially change the properties in undesirable ways also, and often the products are less satisfactory after treatment. Extensive studies need to be made before the effects on any one polymer may be known and the best conditions for irradiation ascertained.—END



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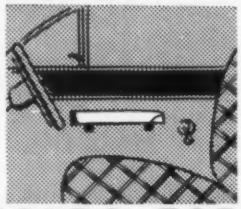

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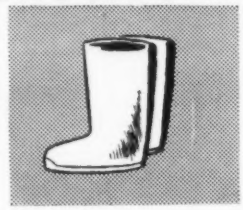

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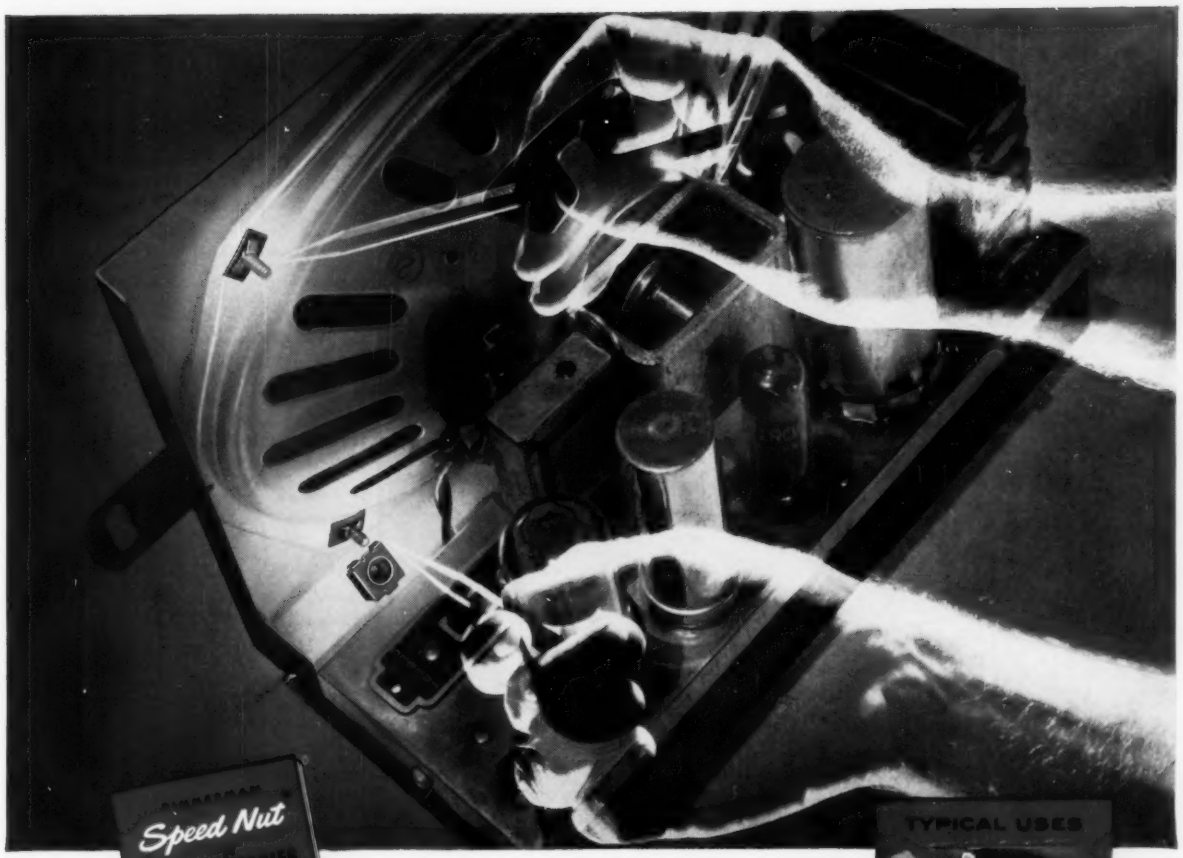

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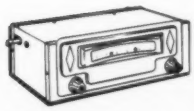

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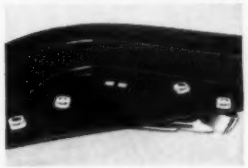

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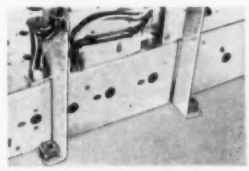

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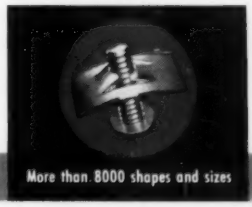

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Formable Sheet

(*From page 103*)

tively little insulation, when compared to direct accelerators which have a single potential drop to account for the entire voltage.

Properties and Applications

The properties of irradiated polyethylene depend primarily upon the electron dose level. The specific application for the item to be treated dictates the dosage. Typical property values for Agilene-HT, a high-molecular-weight polyethylene having an optimum electron dose, produced by American Agile Corp., are presented in Table I, p. 103.

Perhaps the most marked property improvement is increased heat resistance. Irradiated polyethylene does not melt at any temperature if the dose level is sufficient, but it changes from a plastic material to an elastic material as it passes through the ordinary crystalline melting range of 230 to 240° F. Above this range, the inherent strength of the material is not sufficient for most applications except those involving short-period exposures.

When injection molded articles are to be treated with electron bombardment, an important factor to consider is the molding cycle used in manufacturing these items. If articles are injection molded on standard, fully-automatic equipment, they are generally under residual stress due to shock cooling of the molten polymer. Irradiation will definitely not free or eliminate these molding strains. Consequently, even though the molded and irradiated item will not melt at its normal melting temperature, it is elastic enough to deform in an attempt to release this inherent stress. It is imperative that only stress-free molded articles be utilized for any application in which form stability is desired above the normal melting point.

Nevertheless, even strained injection molded items can be recommended for use at temperatures as high as 220° F. after irradiation. This, of course, represents a definite improvement over non-irradiated polyethylene and allows boiling-water sterilization of irradiated polyethylene items at frequent intervals or over long periods of time. Laboratory and hospital ware fall

into this category. If sterilization of polyethylene articles is desired at higher temperatures, for example at 10 p.s.i. steam pressure, the items must be strain-free as produced.

Tubing and pipe of irradiated polyethylene possess excellent corrosion resistance, are practically unbreakable, and have complete freedom from stress cracking. The creep properties of pipe and tubing are improved considerably by irradiation, even with relatively light doses. Thin-walled irradiated tubing can be used as a liner in conjunction with steel pipe, and a complete pipe line can be periodically steam cleaned without harmful effects to the plastic.

Many processes require corrosion-resistant gaskets for use at temporary high temperatures or for continuous temperatures up to 220° F. Irradiated polyethylene solves this problem nicely.

Electrical Properties

The excellent electrical properties of conventional polyethylene have been a strong factor in promoting its use as an electrical insulator. These properties are retained in irradiated polyethylene and appear to be somewhat better than those of non-irradiated polyethylene at high temperatures. Data of this type are very difficult to compare since information on the dielectric properties of molten polyethylene is not readily obtainable.

Although electrical insulators of irradiated polyethylene can be used periodically at temperatures as high as 350° F., continuous operation at temperatures above 220° F. is not presently recommended due to the oxidation of the polymer material. A concentrated effort is now being directed towards the establishment of suitable anti-oxidants for this particular application.

Wire coatings of irradiated polyethylene will prove desirable due to their complete freedom from stress cracking. Stress cracking has been a serious problem with previous lower-molecular-weight polyethylene wire coatings. An irradiated polyethylene wire coating will withstand temporary temperatures to 400° F. without deterioration. This ability to briefly withstand high temperatures without deformation or oxidation will solve the problems encountered in production soldering of conventional polyethylene-coated

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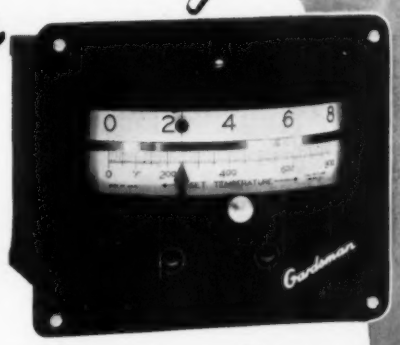

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wire. With present coatings, the soldering heat in many cases is enough to melt the polyethylene in the vicinity of the joint.

Welding Procedure

Process equipment liners can be conveniently fabricated in conventional polyethylene by hot-gas welding. The finished fabrication is subsequently irradiated before installation. Tests have indicated that irradiation induces no loss in weld strength. The excellent weld-strength values of polyethylene in the range of 85 to 95% are retained.

It is important that all operations involving complete or partial fusion of the material be carried out before irradiation, since irradiated polyethylene is no longer fusible. This means that irradiated polyethylene can no longer be extruded, molded, or welded. A particular advantage of the material in tank-lining installations is its increased resistance to stress cracking (5) in certain environments.

Exhaustive tests on sheet stock and on welds have indicated that irradiated polyethylene is completely resistant to embrittlement. In addition, the temperature resistance of the liner is increased to a point where it can be used continuously with boiling solutions.

Formable Sheet

An outstanding application for irradiated sheet is the production of formed articles. When irradiated polyethylene sheet is heated above a temperature of 240° F., it becomes elastic. This elasticity is experienced over a wide temperature range. Under these conditions, irradiated polyethylene behaves very much like crepe rubber does at room temperature. Consequently, in vacuum forming, very deep draws are possible with relatively little temperature control. Thick sections can be drawn quite easily. The wall thickness in sheet-formed items is remarkably uniform. The surfaces of these sheet-formed items are very smooth in appearance. In contrast, conventional polyethylene presents many difficulties in sheet forming due to its narrow melting range. Smooth surfaced items are difficult to obtain and wall thicknesses are almost beyond control when using non-irradiated sheet.

The future for irradiated polyethylene is promising. The cost of irradiated polyethylene is certain to decrease considerably within a short time, making the material available for a much wider range of applications.

Fortunately, polyethylene has been found to be one of the presently available materials most beneficially affected by high-energy irradiation. It is interesting, however, to speculate that future polymers will be tailor-made for subsequent irradiation in such a manner that even greater benefits will be realized.

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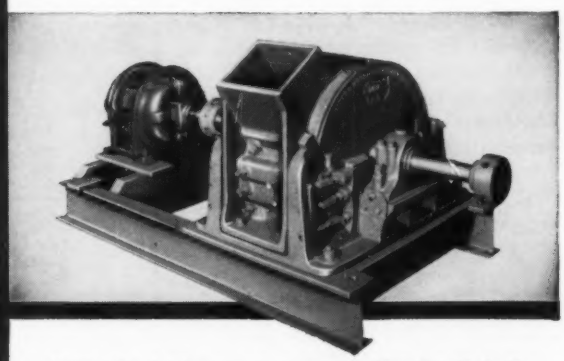

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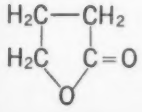
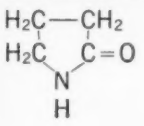
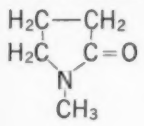
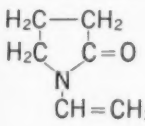
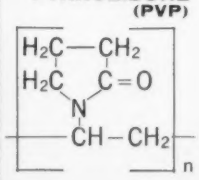
BUTYRO-LACTONE 	Powerful organic solvent for polyacrylonitrile, cellulose acetate, polystyrene, etc. Selective solvent for acetylene in natural gas. Chemical intermediate for aliphatic and cyclic compounds.
2-PYRROLIDONE 	Polymerizes to high molecular weight, linear, nylon-type, polyamide condensation product. Gives γ-aminobutyric acid and derivatives, also N-acyl lactams.
N-METHYL-2-PYRROLIDONE 	Powerful organic solvent for acrylonitrile polymers and copolymers, cellulose triacetate, etc. Selective solvent for acetylene in natural gas. Spinning agent for polyvinyl chloride solution.
N-VINYL-2-PYRROLIDONE 	Will copolymerize with almost all vinyl monomers. Permits modification of many properties in existing homopolymers. Gives control of hydrophobic and hydrophilic properties of products.
POLYVINYL-PYRROLIDONE (PVP) 	Binder, stabilizer, detoxifier, protective colloid, thickener, film former. Physiologically compatible. Wide solubility range. For use in pharmaceuticals, cosmetics, foods, detergents, dye stripping, synthetic fiber additive, size component, lithography, agricultural chemicals, etc.

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Radiation at Work

(*From page* 111)

nuclear energy and chemicals have been conducted on a limited scale. However, the company's research in this field has not been carried to the production stage, except for the wide use of beta ray gages. These instruments are used for controlling and measuring the amount of material used in plastic coating processes at several of General's plants.

The Goodyear Tire & Rubber Co.—Using cobalt-60, this company has done a great deal of work on elastomers and this work has been reported in their literature. Using sulfur-35, research work on various rubber vulcanization processes is proceeding. The company also reports use of the tracer method of determining sulfur solubility and diffusivity in rubber.

Kaiser Aluminum & Chemical Corp.—This company's principal interest is in the application of the electrical insulating materials that are produced by improved processes and techniques, and applications that take advantage of the characteristics that permit improvement in present designs or the possibility of development of new designs.

Koppers Co., Inc.—Through its Research Dept. and Chemical Div., this company has been doing some work with nuclear materials and atomic processes in the development of plastics.

Moldings of straight polystyrene and high-impact polystyrene were submitted to bombardment in a two million volt Van de Graaff generator. The test showed no alteration of tensile strength, impact strength, hardness, solvent resistance, or antistatic characteristics. In all cases the specimens were subjected to bombardment in energy levels ranging from 3 to 100 megareps.

Discoloration was noticeable. Presumably this discoloration is temporary, but the time required to permit it to disappear is believed to be on the order of a month or longer.

Koppers intends to conduct research with polyethylene using nuclear processes, but this program has not yet gotten underway.

The Resistoflex Corp.—This company has followed with great interest the recent developments in the

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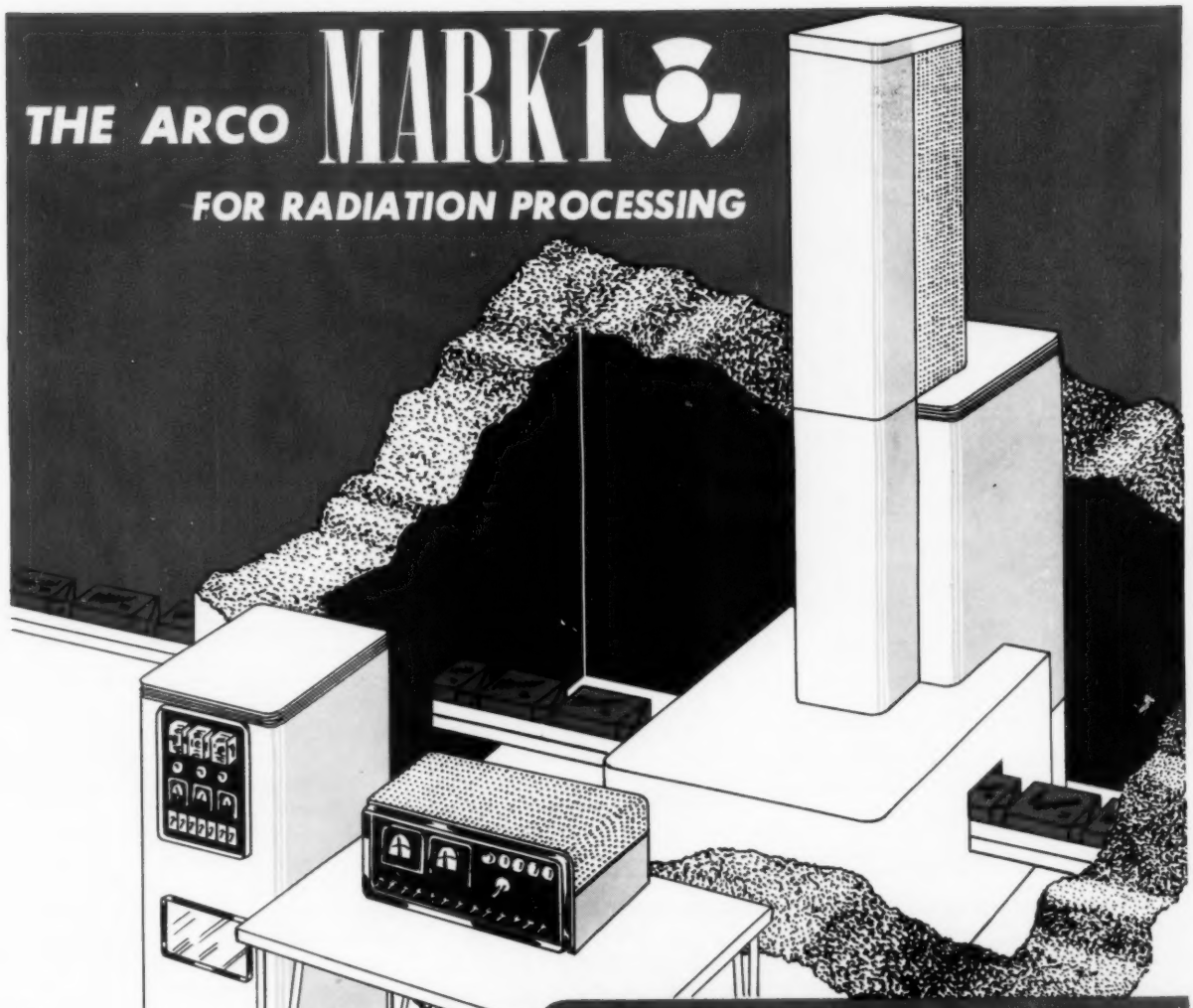

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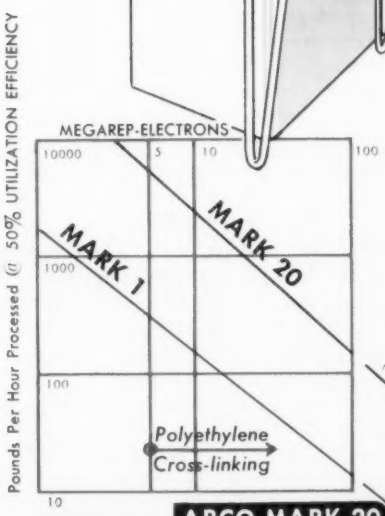

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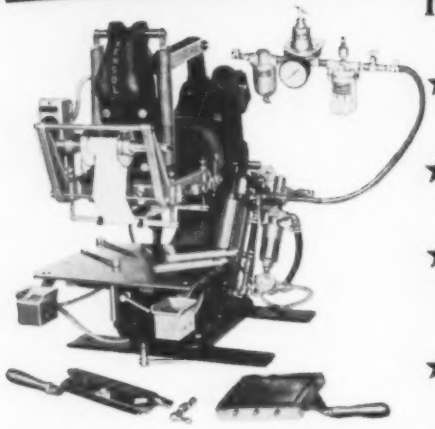

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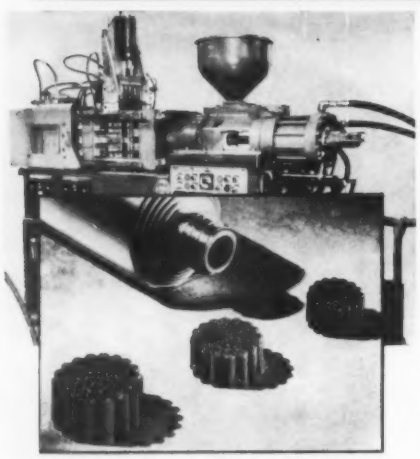

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use of high-energy radiation, and especially its application to the cross-linking of polymer molecules. It has been utilizing the facilities of High Voltage Engineering Corp. to carry out research work on the effects of such radiation upon polyvinyl alcohol. One immediate objective is to determine whether it is possible by the proper dosage to obtain a cross-linking effect such as obtained with polyethylene without excessive decomposition.

Results of these studies have been very interesting but are still inconclusive and the work is being continued. To date, Resistoflex has not found that irradiation of polyvinyl alcohol results in sufficient improvement in properties to warrant its use in production processing.

Resistoflex is quite interested in this new process. However, it has not as yet been able to utilize it commercially.

Standard Oil Development Co.—Standard Oil Development Co., central research and engineering affiliate of Standard Oil Co. (New Jersey), extensively studies and uses polymerization reactions, starting with exploratory experimentation and carrying through to actual process development. Dependent on these reactions are such petroleum-derived products as rubber-polymers, plastics of many types, synthetic surface coating materials, lubricating oil additives, and gasoline components. The influence of gamma rays from cobalt-60 on the reactions which produce these and other products will be among the things explored in the radiation laboratory now being built at the Esso Research Center.

United States Rubber Co.—The effect of atomic radiation on plastics is currently being studied by a research group from the general laboratories. The tests are being made at the laboratory in Passaic, N. J., as well as with outside radiation equipment. The materials being tested include plastics made by the company's Naugatuck Chemical Div. Also under test are other plastics, such as polyethylene. So far the tests have been fundamental, and while the results in several cases have been interesting, it is too early for definite conclusions. Whether or not the irradiation has a beneficial effect depends on the chemical make-up of the material.—END

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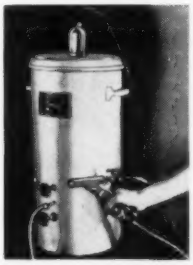

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Super Insulators

(*From page* 119)

zone-heated injection cylinder suspended from a movable platen system actuated by an air cylinder to provide positive locking contact with the mold. The plasticizing cylinder had a 3/8-in. bore and was about 6 in. long. It contained enough plasticized material for two complete shots. An accumulator was also attached to the press permitting the rapid injection rate. The mirror-like surface of the mold was kept clean by swabbing it lightly with an alcohol-saturated cotton swab and by blowing with dry nitrogen.

Molding temperatures closely paralleled the values suggested by the material supplier.

An 85° C. anneal for at least 48 hr. prior to assembly was necessary to relieve strains within the molded insulator. Induced strains lead to surface crazing with subsequent loss of the high insulation property. Only perfect insulators were retained. These were stored in the annealing oven until assembly.

As pointed out above, the prime consideration was the prevention of dust and foreign material from contacting the super insulator. It was not feasible during this development project to construct a special dust-free, air-conditioned room in which to house the molding machine and work areas. Instead, a dust-tight enclosure of plywood, painted on the inside with a smooth, white, easily cleaned vinyl coating and fitted with transparent plastic windows was constructed around the main operating areas of the molding machine. Over-size rubber gloves secured to hand holes in the side of the cabinet enabled the operator to perform all operations necessary to mold an insulator and assemble a complete unit without the parts becoming contaminated. Figure 3 is an over-all view of the equipment and housing. A blower and filter system outside the chamber provided a complete change of clean air within the work area every two minutes. A slight positive pressure on the air within the enclosure prevented dust from seeping or being drawn inside. The cabinet was constructed in two sections. A partition containing an air lock separated the molding area from the assembly

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area. A small laboratory oven in the assembly area was used to anneal and store the molded insulators prior to assembly. The assembly area also contained a dry nitrogen supply for blowing off the mold and inserts, etc., plus the necessary tools and components for assembly of the finished product.

Although the air supplied to the dust-tight box was not dehumidified, it remained at a fairly constant relative humidity of 30 to 40 percent. Dust seemed to be more of a resistance-destroying factor than atmospheric moisture.

Procedure

The conducting probes were washed in alcohol and dried prior to assembly in the mold. Components were handled with tweezers or rubber gloves during all operations to prevent contact with the moisture and natural oils of the skin which would destroy the critical insulating properties of the device.

The mold was put together in the assembly area and passed to the molding section where the polystyrene was injected. It was then returned to the assembly portion of the box and the insulator removed, carefully freed of the sprue and runner, and stored in the annealing oven. A complete cycle required about five minutes.

As further insurance against dust during final assembly, a small amount of powdered graphite, blended in a low vapor pressure vacuum sealing grease, was applied to the lower part of the central probe. The conducting grease served as a trap for any stray dust particles which, in spite of the elaborate precautions, might have adhered to the case interior or one of the chamber components.

Insulator Testing

The quality of the insulators and chambers as a whole was checked by charging the finished ionization chamber and noting the electrical leakage for two weeks. A leakage on the average of 2.42 milliroentgens per 24 hr. was obtained on the development samples. This value corresponds to an electrical leakage resistance for the super insulator of about 0.9×10^{19} ohms. A leakage corresponding to a resistance of 1.44×10^{20} ohms was also registered for one of the ionization chambers tested.

Certain modifications of equipment and technique were necessary when this device was set up on a production basis. An air-conditioned room replaced the dust-free enclosure for the molding and assembly operations; a multi-cavity mold similar to the development mold and cored for heating and cooling purposes shortened the molding cycle. The basic concepts of extreme cleanliness and a super finish on the insulator combined with the techniques for molding and handling this component remained unchanged.

Conclusions

In summary, insulators for pocket ionization chambers can be molded on a production basis from polystyrene that possess electrical leakage resistances in the order of 10^{18} to 10^{20} ohms. Care must be taken to maintain adequate dust and moisture protection, proper molding techniques, and controlled annealing for relatively long periods.—END

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ADHESIVES FOR WEB LAMINATION. Manual lists 26 laminatable materials and indicates the proper "Bondmaster" adhesive to use to laminate each to itself or to any of the others. Materials covered include cellulose acetate, polyethylene, polystyrene, saran, vinyl, "Mylar," cellophane and aluminum foil. Rubber & Asbestos Corp. (C-504)

COLOR PASTE CONCENTRATES. Technical bulletin and price list on 19 different colors for use in coloring epoxy, thiokol, polyurethane and isocyante resins. Chart shows amount recommended for opacity, and provides relative light stability values of each color. Claremont Pigment Dispersion Corp. (C-505)

VERSATILE ALICYCLIC RESIN. Folder gives detailed information on Resin "MS2," an alicyclic ketone condensed resin, which is highly useful in lacquers, enamel and coatings. "MS2" has the ability to reduce and stabilize the viscosity of vinyl plastisols. Howard & Sons, Ltd. (C-506)

ENGRAVING MACHINES. Literature on "Panto" Engraver for three-dimensional reproduction on plastic. The unit is described as being capable of cutting any bas relief design in plastic, and engraving two dimensional lettering in nameplates, signs, molds, etc. H. P. Preis Engraving Machine Co. (C-507)

PYROMETER CONTROLLER. Specification sheet on a pyrometer controller of the potentiometer signalling type which is available in a selection of standard scales ranging from 0-600° F. to 0-3000° F. Thermo Electric Co. Inc. (C-508)

PANEL SAW FOR SIZING SHEET STOCK. Description of several models of a panel saw which may be used for sizing corrugated structural plastics panels, sheet plastics and other sheet materials. Hendrick Manufacturing Corp. (C-509)

REINFORCED PLASTICS. Literature details company's facilities for fabricating and assembling products of glass reinforced plastics. Describes, and gives specifications of reinforced items such as tube, tubing and high-pressure storage bottles for liquids and gases. Fibre-Glass Division, The Apex Electrical Manufacturing Company. (C-510)

ELECTRIC HEAT TRANSFER SYSTEM. Brochure deals with electric heat transfer unit having circulating thermal liquids to provide controlled, uniform temperatures in extruders, dies, presses, platens, calender rolls, etc. Specifications, chart, covers fourteen different models. Gerin Manufacturing Company, Inc. (C-511)

MOLD REFRIGERATION. Folder explains how both production and quality of output are improved when a specially designed industrial refrigerating system is used to maintain mold temperatures. Mayer Refrigerating Engineers, Inc. (C-512)

PLANT FACILITIES. Leaflet illustrates and describes the facilities for custom injection molding available at Pittsburgh Plastics Corp. (C-513)

TEMPLATE AND CAM MACHINE. Literature covers electronically controlled machine which mills or grinds external and internal contours on cams, templates, blanking punches and dies. Machine works from a drawing rather than prototype. Pratt & Whitney, Division Niles-Bement-Pond Co. (C-514)

BRAKE DIES. Literature on custom-built brake dies for sheet materials. Discusses how brake dies are made. Drawings show samples of sizes and shapes possible. Service Machine Co., Inc. (C-515)

CUSTOM MOLDERS. Folder describes and illustrates the facilities and operations of the Romar custom molding service. Pictures company's mold-making, fabricating, designing and finishing departments. Romar Plastics, Inc. (C-516)

EPOXY RESINS AND HARDENERS. Handbook describes Bakelite "C-8" epoxy resin used in making tools, dies or jigs; as an adhesive for bonding a wide variety of materials; and for many difficult molding operations. Compounding and production techniques are discussed. Bakelite Company, Division of Union Carbide & Carbon Corp. (C-517)

GENERATORS. Specification sheet on line of generators ranging from 2½ KW to 6 KW and designed for use with heat sealing equipment where plastic film is fabricated. Mayflower Electronic Devices, Inc. (C-518)

WEATHER TESTING DEVICE. Comprehensive look at the "Weather-Ometer," a laboratory apparatus for ascertaining at a greatly accelerated speed, a trend of reactions which will occur in a product upon subjection to outdoor exposure, sunlight, moisture and temperature changes. Atlas Electric Devices Co. (C-519)

POLYESTER RESIN COMPONENT. Technical bulletin on 1,4-Napthoquinone, a chemical which has applications in the development of polyester resins. Physical and chemical properties are detailed, as well as suggested uses. National Aniline Division, Allied Chemical & Dye Corporation. (C-520)

EXTRUDED PLASTICS. Brochure illustrates over 50 typical cross sections of rods, strips, tubes, and other shapes extruded by this company. Guide section gives characteristics of 10 thermoplastics materials. Anchor Plastics Co., Inc. (C-521)

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MOLD AND DIE MAKING FACILITIES. Bulletin describes the more than 150 pieces of capital equipment including grinders, milling machines, duplicators, lathes, presses, etc., this firm uses in producing and testing custom molds, dies, and hobs for plastics processors. Newark Die Co. **(C-533)**

PLASTICS PRICE LIST. Dimensions, colors, and prices of clear and colored acrylic sheet, extruded acrylic rod and tubing, cast acrylic tubing and rod, and rigid vinyl sheet are covered in this informative bulletin made available by Almac Plastic, Inc. **(C-534)**

MASK WASHING MACHINES. Leaflet on two machines for fast cleaning of electroformed and other spray masks lists specifications and explains method of use. Conforming Matrix Corp. **(C-535)**

HOUSE MAGAZINE. The latest quarterly news letter discusses firm's expansion moves and recent developments in injection molding, along with other items. Lester-Phoenix, Inc. **(C-536)**

PATTERN, MOLD & MODEL MAKING MACHINE. Twelve-page handbook gives specifications on four models of "Vacurator" used in tooling operations. Gives step by step instructions on the use of this multi-purpose unit for making dye and mold cavities, mold cores and punches, slush molds, models and samples. Guy P. Harvey and Son Corp. **(C-537)**

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GRANULATING MACHINES. Folder explains the features, operations and advantages of Leominster granulating machines for reducing sprues, runners, and other scrap to uniform size. Leominster Tool Co. Inc. **(C-541)**

HYDRAULIC LABORATORY PRESS. Information on a 42-ton hydraulic press suitable for both production and experimental work in compression molding, laminating and pressing vinyl sheets. Erie Engine Mfg. Co. **(C-542)**

DIAMONDS FOR MOLDS AND DIES. Bulletin compares advantages of diamond compound and diamond powder for grinding and polishing molds and dies. Describes DTR diamond compound kit. Price list included. Diamond Tool Research Co., Inc. **(C-543)**

TEMPERATURE CONTROLLER. Brochure describes first indicating temperature controller to utilize a thermistor as the sensing element. Tells how the controller's design achieves selective control, mechanical and electrical stability, and simplicity of operation and maintenance. Fenwal Inc. **(C-544)**

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Molds for Forming

(*From pp.* 124-125)

form, mixed with 5 gal. of distilled water. The other, or reducing solution, consists of ½ pt. of formaldehyde and dextrose, also mixed in 5 gal. of distilled water.

With the model mounted in a spray booth, both solutions are sprayed simultaneously onto its surface (Fig. 4) from a two-nozzle spray gun. The mixture of these two solutions in the air and on the model's surface causes a chemical reduction of the silver nitrate solution, and produces a pure silver deposit.

The next step consists of attaching the anodes to the model. For simple, shallow shapes, the anode need be simply a bar which is connected electrically to one or two contact points on the silver surface of the model. For more intricate shapes, and especially for deep, confined sections, the anode system is an intricate network of bars and rods so that the electroforming process will build up the metal with uniform thickness.

With the anodes properly attached, the sensitized model (Fig. 5) is immersed in a standard nickel plating bath. After about 2 hr. in the bath and the application of a plating current of about 20 amp./sq. ft. of model surface, a skin of approximately 0.001 in. of nickel plate will have been built up.

The plated model is then removed from the nickel bath and thoroughly washed, after which it is placed in a copper plating bath where it remains for four to six days of continuous plating using a current of from 30 to 35 amp./sq. foot. During this entire time the plating solution is agitated by compressed air. At the end of the 130- to 144-hr. plating period, a shell of copper with a thickness of from 0.125 to 0.150 in. will have been built up on the 0.001-in. skin of nickel.

The shell is now removed from the male model (Fig. 6). It is generally necessary to grind off excess metal around the edge of the model-mold unit so that the two sections can be separated. If a female mold is the desired goal, the cooling coils are now placed in position in the electroformed shell and the metal backing is cast as previously described.

When a drape forming or male mold is required, another plating or electroforming operation is necessary. In preparation for this, the nickel surface of plated female shell is sprayed with a stripping or parting agent. Sodium dichromate is generally used for this purpose. Such a parting agent does not destroy the conductivity of the nickel surface yet it assures that the female master and the male mold built up on it can be easily separated. After spraying with the parting agent, the plating operation is repeated until the male shell has been built up to the proper thickness. After the shell and master have been separated, the cooling coils are positioned and the backing is cast.

Such electroformed molds for use in vacuum forming are ideally adapted to long production runs. They have few limitations as to size and shape and produce formed parts with excellent surfaces. Fine detail can be held and production speed is not limited by thermal build-up in the molds themselves.—END

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(*From pp.* 129-134)

cross-linking or branching. Polymer C degraded as shown by the decrease in flow viscosity. It is important to note that in all these experiments the sample was kept in the viscometer for 10 min. before measurements were made. Ten minutes is considered the minimum time before temperature equilibrium is attained. Therefore, 10 min. must be added to the time indicated on the curve to obtain the total time in the viscometer.

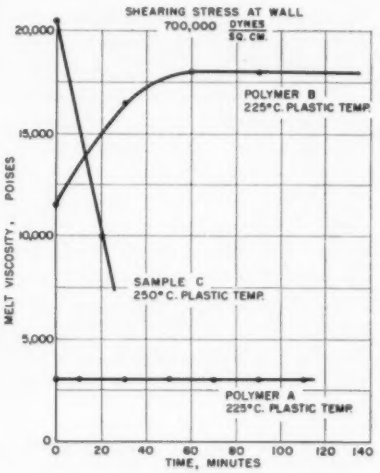

Fig. 7—Flow viscosity as a function of time for three polymers

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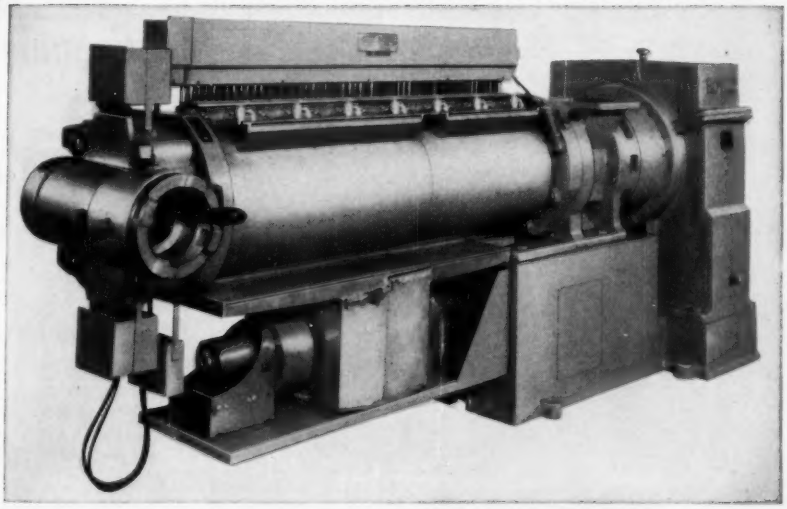

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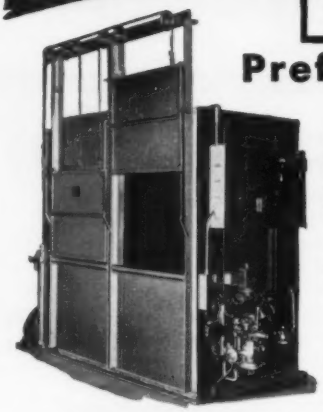

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Mechanical

(*From pp.* 139-144)

the ability of a material to support sustained loading in them.

Stress-corrosion-rupture tests provide a significant measure of the effects of time, temperature, and environment upon a stressed material and can be used to evaluate it for structural applications.

Because the water environment reduces the design stresses of structural plastic laminates, its effects should be considered in any installations where long-time exposure to water is anticipated. If some environment other than water is present, its effects upon the stressed material should be determined.

Rupture stress-time curves for these materials did not show a tendency to "level off" at test periods up to 1000 hours. Extrapolation of these data to longer periods of time may be made, but is hazardous.

This method of analysis and testing is now being used to evaluate laminates based upon polyester, phenolic, epoxy, and silicone resins. It has proved equally versatile in studying molding materials that have brittle stress-rupture characteristics.

Acknowledgment

The authors wish to acknowledge the fine cooperation of Mr. P. A. Thomas of the Bakelite Development Laboratories.

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2. Tensile properties: A.S.T.M. method D 638-52T; specimens were as per Type I, Fig. 1, Section 5A. A Baldwin extensometer, Model PS-6M, was used to measure elongation.

3. Flexural properties: A.S.T.M. method D 790-49T; specimens were as per Table I, paragraph 3. A Baldwin PD-1M deflectometer was used to measure deflection.

4. Compressive properties: "Plastics, Organic: General Specifications, Test Methods," Federal Specification L-P-406b, Amendment-1 (Sept. 25, 1952); see also A.S.T.M. method D 695-52T. A Baldwin Compressometer, model PC-7M, was used to record compressive deformation data for the laminates.—End

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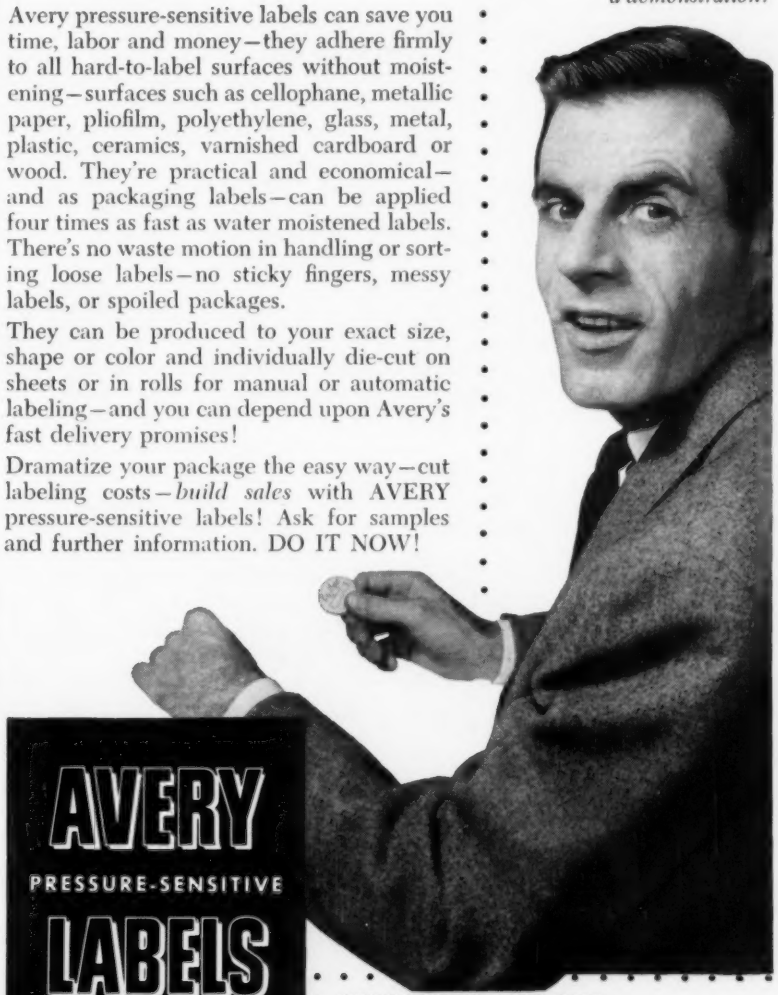

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THE PLASTISCOPE*

NEWS AND INTERPRETATIONS OF THE NEWS

By R. L. Van Boskirk

Plastics in Automobiles

IMPORTANCE of the automotive industry as a market for plastics materials continues to grow each year and is expected to reach a new high in 1955, provided that the goal of 5,700,000 cars is reached by the end of the year. (See accompanying Table I).

As listed in Table I, the figure denoting the amount of vinyl chloride used by the automotive industry is based on solid resins. The total vinyl compound figure, including plasticizers and fillers, could run anywhere from 20 to 25 million pounds.

The largest amount of vinyl chloride resin goes into vinyl-coated fabrics for upholstery, trim, and linings. One pound of resin will cover a large area of fabric for such purposes. Very little unsupported film or sheeting is used.

The average amount of vinyl used per car for such things as wire covering, door stops, back windows, and welting is small, especially since the demand for fender welting dropped off. If more cars adopted vinyl welting for window channeling, the poundage would go up considerably.

Rigid vinyl sheeting for such things as kick plates, front seat side shields, and other interior linings may eventually claim a part of the total poundage of vinyl going into the automotive industry. These applications were once wood but are now generally made of metal covered with vinyl or cloth. The inner lining for the top of the car may also eventually switch to rigid vinyl from vinyl-coated broadcloth. Other plastics such as Royalite, Kralastic, and high-impact polystyrene are, or soon will be, under trial for this application. The heat build-up in car interiors is so high during hot summer days that thermoplastic sheet car ceilings must be carefully chosen in order to prevent heat distortion.

The other plastics materials listed in the table are used for conventional applications previously discussed in detail in the pages of MODERN PLASTICS.

Figures for phthalic anhydride and nitrocellulose are given because of their relationship to the plastics or synthetic industry. They make up a good portion of the 7 gal. of paint or surface coating for each car, including that used for chassis, cylinder heads, and other mechanical parts. About 4 gal. per car is body paint.

General Motors and Packard use fast-drying nitrocellulose lacquers. Most of the other car manufacturers, with the exception of Lincoln, use alkyds. The baked enamels, which are roughly 85% alkyd and 15% melamine, or 80% alkyd and 20% urea, are estimated to average about 3 lb. of phthalic anhydride per car. The dry weight of nitrocellulose used in lacquers for each car is estimated at 2½ pounds. An unestimated amount of other materials, such as alkyds, melamine, urea, and rosin, make up the balance of the lacquer content.

Table I—Plastics Poundage for Automotive Use

	1954	1955
No. of passenger automobiles	5,500,000	5,700,000
	lb.	lb.
Methacrylate	5,500,000	7,400,000
Butyral sheeting	14,000,000	17,000,000
Cellulose acetate butyrate	5,000,000	5,200,000
Phenolic molding material	5,000,000	5,200,000
Vinyl chloride (solid resin)	15,000,000	17,000,000
Nylon	2,600,000	3,800,000
TOTAL	47,100,000	55,600,000
Phthalic anhydride	16,500,000	17,000,000
Nitrocellulose (solid)	7,200,000	7,500,000

Cyanamid's New Thermoplastic

VARIEGATED resins of the styrene type are threatening to become the most populous member of the plastics family. There are already a dozen or more in the field and more to come.

Latest to announce its entry into the field is American Cyanamid Co. which has announced that a plant is now under way in Wallingford, Conn., which will eventually produce some 40 million lb. of thermoplastic molding compounds to be processed from monomethyl styrene supplied by the company's Fortier plant near New Orleans, La. The new plants are not expected to begin production until some time in 1956.

The company is reluctant to divulge further information at this time, but the trade has been buzzing about the American Cyanamid situation ever since the company let it be known that experimentation was going on more than a year ago.

It is known, for example, that methyl styrene can be produced from toluene or even xylene instead of benzene which is used for standard styrene monomer. Toluene and xylene are less subject to the shortages common to benzene during emergency periods, and furthermore, are considerably less costly. Methyl styrene is practically the same material as vinyl toluene which has been in production by The Dow Chemical Co. for more than a year. Hercules is also a possible entrant into the field since the company can produce methyl styrene as a coproduct of its new phenol and acetone plant.

Some chemists assert that molding material produced from methyl styrene is likely to be more brittle than traditional polystyrene, but other chemists assert that it can be modified or copolymerized with other monomers, such as acrylonitrile, to obtain a good impact material that is tough and craze resistant. Furthermore, it is well known that res-

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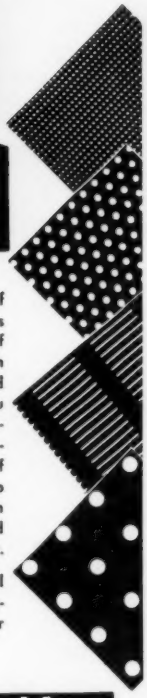

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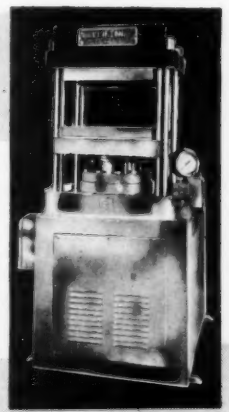

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ins produced from methyl or alpha methyl styrene have greater heat resistance than traditional polystyrene. Since Cyanamid is the largest producer of acrylonitrile, it is logical to assume that the company has its eyes set on either a modified or copolymerized styrene to add to the long list of those now available.

Durez and Hooker

STARTING out in 1921 with a few thousand dollars worth of assets, Durez Plastics & Chemicals, Inc., Tonawanda, N. Y., has grown into an organization that drew an approximate $50 million purchase price when directors announced that it would be merged with Hooker Electrochemical Co., Niagara Falls, N.Y. Provided that stockholders approve, and there is no indication of objection, the issuance of 1,650,000 shares of Hooker's stock to Durez stockholders will bring total issued shares of Hooker common stock to over 5 million. One share of Hooker was issued for each share of Durez. The 1,650,000 shares were estimated at an average of $30 each.

Durez' gross net income at the end of 1953 was $7,340,000. No sales figure was published. Hooker sales for 1954 were $45 million, with a net income of $4 million. It is estimated that the merger will increase Hooker's sales by approximately 50 percent.

Durez management will remain as at present, but since both firms are located in close proximity, it is expected that substantial savings will be made in general administration and operation.

Durez now operates phenolic resin, formaldehyde, and phenol plants in North Tonawanda; a research laboratory at LeRoy, N. Y., 40 miles from Buffalo; and a wood flour plant in Spokane, Wash. A new 60 million-lb. phenolic plant in Kenton, Ohio, will start operations soon. In addition, Durez owns a site between Pittsburgh and Buffalo which has not been developed.

Hooker will celebrate its 50th anniversary this year. The company manufactures over 100 chemicals at its three plants located in Niagara Falls, N. Y.; Montague, Mich.; and Tacoma, Wash. The only plastic so far included in the firm's line is Hetron, a heat-resistant polyester resin. The Montague plant is one of the nation's comparatively new caustic soda-chlorine plants that has been built since the Korean war and is next door to Du Pont's Neoprene plant for which it is a principal supplier of chlorine. During the past year, the company has also expanded its ammonia capacity at Tacoma; increased by four-fold its capacity for making C-56, the basic product for Hetron; and started operation of a plant for the Atomic Energy Commission at Model City, N. Y., about five miles from Niagara Falls.

Filling Polyethylene Tubes

IN ORDER to facilitate the use of polyethylene tubes and "squeeze-to-use" bottles produced by Bradley Container Corp., Maynard, Mass., several contract packaging firms have developed equipment to fill and seal the units.

Among those who now have equipment to fill the Bracon tubes made by Bradley are Chemical By-Products, Ltd., Toronto, Ont.; Tubed Chemicals Corp., Easthampton, Mass.; Paket, Inc., Chicago, Ill.; R. Hurwich Co., Berkeley, Calif.; Old Empire Mfg. Chemists, Inc., Newark, N. J.; and Evans Chemetics, Waterloo, N. Y.

Filling and sealing equipment to handle tubes, specifically designed by A & M Tool & Die Co., Southbridge, Mass., is now available. Five of the new fillers were shipped in one week by A & M. Bottle sealing equipment is manufactured by Horix Mfg. Co., Pittsburgh, Pa., and MRM Co., N. Y. This equipment will automatically fill and seal Bracon bottles with the seal achieved by heat welding a round disk to the bottle walls.

Bradley has also announced the appointment of various representatives in all parts of the country to handle regional sales of the containers.

The Bradley cylindrical bottle container seems to have already created a particularly big stir in the container industry. It has proved applicable for such things as foot powder, flea powder, talcum powder, or most anything else in powder form. One squeeze per puff seems a much easier way to dispense powder than the method required by the traditional shaker-type container.

New Entrant in Vinyl

OPERATION of a sizable new polyvinyl chloride plant near Natchez, Miss., is contemplated by Simpson Coal & Chemical Co., 120 Wall St., New York, N. Y., by the end of 1956. The new facilities will be part of an enterprise contemplated to produce 30,000 tons of acetylene and 60,000 tons of ammonia per year. Both vinyl chloride monomer and polymer production are planned.

Acetylene will be produced by the oxidation of natural gas. Co-products will be nitrogen, ammonia, hydrogen, carbon monoxide, and carbon dioxide. Reportedly, acetylene produced by the oxidation method is less costly than that produced by the more common carbide method, partially because of the large variety of co-products that will be produced.

The proposed operation is similar to that of the contemplated Gulf Chemicals plant near Pensacola, Fla., which is also supposed to come into production in 1956. Carbide and Carbon, as well as Monsanto, also operate acetylene plants at Texas City, Texas, which use the oxidation process.

Simpson is a Div. of Standard Ore and Alloys Corp. which has European roots going back 80 years or so. The president is Jacob Michael, formerly of Germany and Holland. Standard has been a holding company that once operated 15 or more enterprises in Europe, but most of them have reportedly been sold.

Simpson now has a small organics operation near Newark, N. J.; two coal mines in West Virginia; and the new modern Bradbury mine in Sparta, Ill. Mid-west Utilities Coal Corp., Chicago, Ill., a subsidiary of Standard Ore and Alloys, operates the Bradbury mine. David W. Wollin is vice president in charge of operations of Simpson.

A spokesman for the organization indicated that the present disparity between an annual sales figure of around 400 million lb. and capacity of about 650 million lb. of vinyl chloride resin in this country would be no deterrent to the company's

plans to build new vinyl facilities. Even a possible severe decline in the current price of resin would be no deterrent, he thought. The organization is apparently building its future on the possibility of low-cost acetylene from which to produce vinyls (see MODERN PLASTICS, p. 104, September 1953) and feel that consumption of vinyls will grow at a lot faster rate than it has in the last two or three years.

Bamberger Sale

PURCHASE of A. Bamberger Corp. and its affiliate, American Molding Powder & Chemical Corp., 703 Bedford Ave., Brooklyn 6, N. Y., has been announced by Norman Eisenstein, president of Ansbacher-Siegle Corp., Rosebank, N. Y., and Federal Color Laboratories, Cincinnati, Ohio, manufacturers of colors for the plastics and other industries. Ansbacher-Siegle was once an affiliate of I. G. Farben and subsequently of Heyden Chemical Corp., but has been an independent under the presidency of Mr. Eisenstein for several years.

The management of Bamberger will continue under its present officials as follows: Gerald F. Bamberger, executive vice president; Herbert H. Goldmark, vice president and sales manager; Matthew T. Staszak, vice president and plant manager; and Arthur L. Metzger, vice president and sales manager of the Vinyl Dept.

A. Bamberger Corp. is one of the largest reprocessors of plastics materials in the country and American Molding Powder & Chemical Corp. is the manufacturer of Ampacet thermoplastic molding compounds.

Flexible Coatings

EXCELLENT dielectric properties for a material that cures at room temperature and may be applied by brushing, spraying, or dipping is claimed for Micro Lite ML 88 by Radar Relay, Inc., 2260 Westwood Blvd., Los Angeles 64, Calif.

Originally developed by North American Aviation, Inc. as a rain erosion-resistant material, ML 88 would naturally have good resistance to abrasion. Tests have disclosed the material to have a dielectric strength of 1000 v./mil, with isolated tests showing as high as 2000 v./mil. High- and low-temperature characteristics are reported to be excellent, with no cracking or breaking under flexing at −65° F. A fully cured film may be intermittently subjected to 400° F. without deformation.

The coating has a wide range of application, including waterproofing automobile ignition systems, protecting wire harnesses and panels subject to abrasion, protecting battery terminals, and encapsulating resistors, transformer windings, and relay coils. The material's ability to cure at room temperature makes it usable with components unable to withstand the high temperatures required to cure other encapsulating compounds.

Micro Lite ML 88 is available in ¼-, ½-, and 1-pt. and 1-qt. containers, together with a small can of the necessary catalyst. Shelf life of the material is six months, and the material should be used within 48 hr. after addition of the catalyst. Complete polymerization requires two weeks, but the coating will cure sufficiently for handling in four hours.

H.P.M. Merger

THE respective boards of directors of The Hydraulic Press Mfg. Co., Mount Gilead, Ohio, and The Lodge & Shipley Co., Cincinnati, Ohio, have announced that the two companies have arrived at an agreement whereby Lodge & Shipley would acquire The Hydraulic Press Mfg. Co. through a merger.

Bakelite's New Rigid Vinyl

ESPECIALLY adaptable to the production of corrosion-resistant tanks, ducts, and similar structures, a new calendered rigid polyvinyl chloride sheet has been developed by Bakelite Co., a Div. of Union Carbide and Carbon Corp. The new material meets S.P.I. specifications for Type I rigid sheet for structural purposes. It is easily machined and fabricated from sheets as large as 4½ by 10 feet.

The sheet is suggested for such applications as self-supporting electroplating tanks, ducts and exhaust hoods for corrosive fumes, and laboratory ware, including beakers, bottles, and funnels for handling, storing, and transporting corrosive liquids and solids.

Like Bakelite vinyl copolymer sheets, the new polyvinyl chloride sheet is self-extinguishing, and its higher heat distortion point of 160° F. fits in with requirements for applications such as backlighted signs and fixtures, instrument dials, and parts of military and electronic equipment.

Tests show that the material will withstand 750 to 1000 hr. exposure to Florida sunlight before blackening, an advantage over similar materials which have been modified to gain impact resistance at the sacrifice of weather resistance.

Bakelite is producing both natural unpigmented and opaque rigid polyvinyl chloride sheet in thicknesses from 0.010 to 0.015 in. in continuous rolls up to 51½ in. wide. Planished sheets measuring 20 by 50 in. are available up to 1¾ in. thick. Larger planished sheets may be obtained through custom laminators.

Fir Plywood Jubilee

WESTERN fir plywood manufacturers are celebrating their 50th anniversary this year with a Golden Jubilee promotion aimed at increasing sales by 10 million ft. a week throughout the year. The statement came from the Douglas Fir Plywood Assn., Tacoma, Wash., representing Washington, Oregon, and California's 97 fir plywood mills which produce three quarters of the nation's panels.

Manufacturers will invest through their association at least $2.5 million in developing fir plywood markets this year. Per capita consumption has been boosted from under 10 sq. ft. to more than 23 sq. ft. since World War II.

For consumers, the industry will offer a book of 50 plans for all kinds of do-it-yourself projects from a smart modern new wall desk to an entire carport and storage section. Lumber dealers will be provided with tested point-of-purchase displays and will be given more promotion support from field representatives of the fir plywood industry than ever before. During the past two years, the force has been more than doubled and there is now a total of 27 field promotion representatives.

The industry hopes it will push sales this year well past the 4 billion-ft. mark. This means an increase of about 10 percent. Despite a 12-week strike in mid-summer, affecting 50% of industry production, 1954 sales of fir plywood

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reached 3.8 billion ft., 4% better than 1953, the previous record high.

At the present time, the industry holds a backlog of over 500 million ft. in new orders.

The fir plywood industry uses between 30 and 40 million lb. of phenolic resin solids each year.

Plastic Foam

THREE new foam products—Fashon-Foam, Fashon-Foam I.S., and Fashon-Foam P.V.—have been developed by The General Tire & Rubber Co., Akron, Ohio.

Fashion-Foam is a latex material used for mattresses. Fashon-Foam I.S., named after its isocyanate base material, is used in such applications as furniture, shoe soles, cushioning, and air filters. Fashon-Foam P.V. is being used for padding and cushioning in various fields.

Plasticizer Blends

ANNOUNCEMENT of a new series of plasticizer blends, designed to reduce plasticizer costs without sacrificing quality, has been made by Pittsburgh Coke & Chemical Co., 2023 Grant Bldg., Pittsburgh 19, Pa. The new blends were developed by the company as a part of its over-all program to provide the industry with better plasticizers at lower cost.

One of the new series of formulations developed is a blend of Pittsburgh PX-114 (decyl butyl phthalate) and Pittsburgh PX-118 (iso-octyl decyl phthalate). Duncan MacLennan, sales manager of the Plasticizer Div., states that this new blend compares very favorably with D.O.P. in every important respect and can replace D.O.P. in a wide range of applications.

Reinforced Plastics Caps for Lightning Arresters

LIGHTNING arrester caps made from Glastic, a fibrous glass-reinforced polyester resin, are now being used in place of glazed porcelain caps by General Electric Co. in its standard pellet-type distribution arrester line.

The new cap, manufactured by The Glastic Corp., 1823 E. 40th St., Cleveland 3, Ohio, is smaller, weighs less, has far greater impact strength, and presents a more streamlined appearance than its predecessor.

Although polyester-glass parts have been used for numerous electrical insulating applications in the past, this is claimed to be the first time that such material has been utilized for parts in outdoor distribution-type lightning arresters of any kind.

The cap is designed primarily to prevent accidental contact with the line conductor which constitutes the top of the arrester, and must have excellent weather-resistant characteristics.

Polyethylene Laminator

FIRST machine in the West to laminate plastics to paper is now in operation at the N. Portland, Ore., plant of Western Waxed Paper Div., Crown Zellerbach Corp. The $135,000 polyethylene extrusion equipment lays a thin film of plastic on any paper, from tissue to heavy cardboard, making it virtually impervious to water.

Besides its use for food packaging, plastic-coated paper is proving useful to nurserymen for wrapping peat moss. It reduces evaporation during shipment and requires less wrapping material.

Diamond's New Chloride Resin

DESIGNED specifically to meet steadily increased demands for a resin that can be processed at temperatures from 315 to 330° F., a new polyvinyl chloride resin has been developed by the Plastics Div., Diamond Alkali Co., 300 Union Commerce Bldg., Cleveland 14, Ohio.

Similar in characteristics to Diamond P.V.C.-50, first introduced by the company in 1953, the new resin has a lower specific viscosity than the former material, with a correspondingly lower molecular weight. It is not intended to replace P.V.C.-50, but to supplement it.

The new polymer, Diamond P.V.C.-45, is also said to have high bulk density, excellent heat stability and color retention, and dry-blending and free-flowing properties required in materials of this type used in producing vinyl sheeting and film, non-electrical extrusions, and molded products.

Packed in 50-lb. bags, P.V.C.-45 is now being produced at the manufacturer's Deer Park plant in Houston, Texas.

Emulsifiable Polyethylene

LIMITED quantities of emulsifiable-type A-C polyethylene for evaluation on plant run scale are now available from Semet-Solvay Petrochemical Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.

The company states that small particle size, stable, clear, high-solids-content emulsions are readily obtained with the new material. Its color and the competitive advantages of its stable price give the material a considerable edge over higher cost vegetable waxes which frequently fluctuate in price.

Possible applications for the material include liquid coatings for glass, paper, boxboard, textiles, and leather. The material is also claimed to have good market potential as an ingredient in floor and shoe polish formulations and other protective coatings.

In another phase of Semet-Solvay's operations, it is reported by companies coloring polyethylene products that low-molecular-weight A-C polyethylene has performed favorably as a color carrier.

The material is said to promote faster dispersion of pigments and provide an economical, practical method of introducing color into film and extrusion types of polyethylene products.

Prices are quoted delivered in the United States and range from 40 to 52¢ a lb., depending upon grade and quantity. A complete list of A-C polyethylene prices and additional information may be obtained from Semet-Solvay.

Flexible Label for Flexible Polyethylene

DEVELOPMENT of a new flexible label to be used for labeling polyethylene containers or other containers made of flexible plastic or rubber has been announced by Fleetwood Press, Inc., 1668 Boone Ave., New York 60, N. Y.

When a plastic bottle is squeezed, the label "gives" with the bottle, but returns to its original shape

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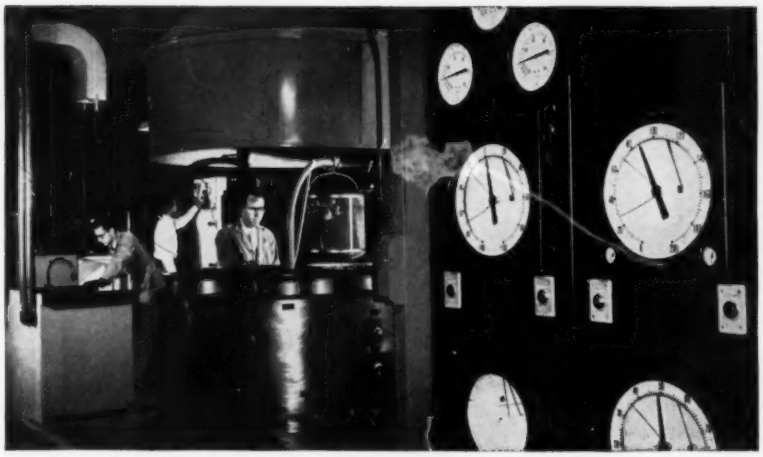

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What is Plastiatrics

Plastiatrics sounds like a medical term. It's no accident. Since Dow's first plastics were made, we have subjected them to: *diagnosis*, to determine their limitations and complaints—*prognosis*, to determine the course and termination of manufacturing problems—and *treatment*, prescribing a course of action or physical remedies for their ailments. Professional analysis and experience is making it possible to *cure* many plastics problems and prevent possible afflictions. The general practice of scientific inquiry and treatment of plastics and their healthy uses is a profession at Dow. Plastiatrics, we call it.

The Plastiatrics Laboratory

Good research requires modern equipment, but the tools are only as good as the men who use them. Dow Plastics Technical Service is staffed by engineers and technicians who have devoted their careers and their skills to the study of plastics materials, processes, testing methods and their evaluation. The knowledge and experience these men have gained are tremendous in scope. They work with standard commercial fabricating equipment, not laboratory models, to integrate materials and processes with careful attention to practical economics. Experiment and development can be carried out on commercial scale from raw material formulation through specialized processes and finishing. Field service in fabricating plants and participation in trade standards committees further extend the work of the laboratory. The reliable reports and engineering data of Plastics Technical Service are the foundation of Plastiatrics.

Plastiatrics Helps Industry

Dow seeks to promote the use of plastics wherever that use is sound, and discourage it where other material can be used more advantageously. With Dow, the interest of the manufacturer or molder is paramount. Problems and their solutions or supporting data are stated in standard engineering terms so that technically trained people in other fields can use them. Dow will furnish confidential evaluation of finished or proposed plastic parts or their blueprints. Service work may include consultation on special developmental techniques. Considerable experience is available to the manufacturer with regard to appropriate dies, jigs and fixtures and molded parts. Materials are modified or developed according to the requirements of industrial application. Like preventive medicine, Plastiatrics can ward off trouble before it starts.

Plastiatrics Series to Follow

Results of clinical reports will appear in these pages from time to time. For a complete summary of Dow products and services, write for "Dow Plastics Materials and Technical Services", The Dow Chemical Company, Plastics Sales Department PL 453R, Midland, Michigan.

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- **Styron 777** . . . for medium-impact strength.
- **Styron 475** . . . for high-impact strength and high elongation.
- **Styron 475 sheet** . . . for vacuum or pressure forming.
- **Styron 480** . . . for extra-high-impact strength.
- **Styron 700** . . . for high heat resistance.
- **Styron 637** . . . for improved light stability.

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when pressure is released. The company states that Fleetwood labels for the first time make it possible to put real color and design into squeezable bottles. The labels can be applied by conventional methods, requiring no change in equipment.

Perforated Vinyl

ACQUISITION of Atkin Mfg. Co., Toledo, Ohio, has been announced by The General Tire & Rubber Co., 1708 Englewood Ave., Akron, Ohio. Jules D. Lippmann, general manager of General Tire's Textileather Div., has been named president of the Atkin organization. He states that Atkin's original perforating processes for vinyl, metal, cloth fiber, and fiber-board materials will bring about an expansion of the Textileather operations.

In addition to its perforating business, Atkin holds a license for the manufacture of perforating machinery, and Mr. Lippmann expects to expand this phase of the company's operations.

S.P.E. Section Officers

OFFICERS of the Southern California Section, Society of Plastics Engineers, Inc., have been elected as follows:

President: Walter H. Kadlec, E. I. du Pont de Nemours & Co., Inc.

Vice president: Paul A. Erskine, Hess, Goldsmith & Co., Inc.

Secretary: A. Allen Ray, Ray Products Co., Inc.

Treasurer: Harold F. Dague, Collins, Caldwell & Dague.

Officers of the Connecticut Section of S.P.E. are:

President: Robert P. White.

Vice president: David Mersey.

Secretary and national director: John E. Burger.

Treasurer: S. C. Svenson.

Price Reduction for Film

PRICE reductions ranging from 3½ to 12% on Visqueen polyethylene film have been announced by The Visking Corp.'s Plastics Div., Terre Haute, Ind.

E. B. Cahn, general manager of the division, states that the reductions are the result of Visking's expansion program and their improvements in extrusion techniques.

According to Mr. Cahn, Visqueen will now become the lowest priced transparent plastic packaging film on the market today, and will open new markets for the use of polyethylene. Basic price for Visqueen film is now 59¢ a lb. in quantities of 1000 lb. or more; the former price was 61¢ a pound. Tubing, 3 to 5 in., is about 82¢ in comparison to a former price of 93¢ in 10,000-lb. lots, but there are price variations in a wide range due to quantities and sizes ordered.

The cost of 1-mil polyethylene film per 1000 sq. in. was estimated to be about 2¢ before the price reduction. Estimates for other materials per 1000 sq. in. are moistureproof cellophane, 2.7¢; plain cellophane, 2.6¢; glassine, 1.2¢; and extruded 1-mil vinyl, 4.24 to 4.93 cents.

Visking recently announced that its new $1 million plant in Flemington, N. J., had started producing film, the company's third such operation in the United States. The other plants are located in Terre Haute, Ind., and Centerville, Calif. In addition, Visking has plants in Canada, England, and France producing film. Plant supervisor at Flemington is Charles H. Molitor.

Blown Vinyl Sponge

VINYL sponge produced by the use of chemicals which release gas, generally nitrogen, has small pores, low density, and is a highly resilient open cell material.

Advance Solvents & Chemical Corp., 245 Fifth Ave., New York 16, N. Y., has introduced a new plasticizer, called Plastoflex SP-2, to be used in conjunction with Du Pont's blowing agent BL-353 for atmospheric blowing of the open cell type of vinyl sponge described above. The finished product will also have flame resistance and a low odor level.

In curing this material, Advance Solvents suggests that the plastisol be cast in prewarmed molds and heated in an oven at 210 to 220° F. from 10 to 20 min. until the initially yellow color of the plastisol turns completely white, and no further rise of the sponge is noticed. The molds are then transferred to a second oven and heated at 330° F. for 10 to 20 min., depending upon the cross-section of the mold. Cross-sections over 2 in. in diameter should be, for best results, cured by high-frequency heating. The cured sponge should not be removed from the mold before it has thoroughly cooled.

World Plastics Fair

EMPHASIS will be on recent applications and techniques at the World Plastics Fair and Trade Exposition to be held in Los Angeles, Calif., April 6 to 10, 1955. One of the interesting exhibits will be an educational presentation whereby visitors will push buttons and levers to initiate mechanically activated tests of plastics materials.

Producers of industrial products and furniture, interior and graphic art designers, engineers, plastics material manufacturers, and companies that process and fabricate all types of plastic products are invited to submit samples of their work for inclusion in the special exhibit. Information about the Fair may be obtained from Fair Management, 8762 Holloway Dr., Los Angeles 46, Calif.

Plastisol Products

CALLED Kylon, a new vinyl plastisol has been announced by Polymer Dispersions Co., 29 Grove Ave., Port Richmond, S. I. It has already found use as a paper coating, a dipping compound, and for foaming. The company suggests that it may also be used for free-film casting.

Kylon plastisol is non-toxic and has good low-temperature characteristics. It is non-flammable, possesses good tensile strength, and can be bonded during fusion to a wide variety of surfaces when Kylon latex primers are used.

Polystyrene-Glass

PRODUCTION of custom molded plastic parts from injection molded glass-reinforced polystyrene has been started by the Plastics Div., Erie Resistor Corp., Erie, Pa. The company is among the first plastic molders in the country to injection mold this new material for decorative industrial applications and in parts for the home appliance field.

William C. Conroy, sales manager of the division, in making this announcement, stated that a portable

radio cabinet, which is a part that Erie is custom injection molding from glass-reinforced polystyrene, will support the weight of a large man without cracking.

Plastics Institute

A PROGRAM for an Industrial Plastics Institute, to be held from March 14 to 15, is being planned by the University Extension Division, in cooperation with the College of Engineering, at The University of Wisconsin, Madison 6, Wis.

Some of the subjects to be discussed are future uses of polyethylene, metallizing and finishing plastics, silicones, plastics tooling, polyesters, and epoxies.

Saves 50% by Using P.V.C. Pipe

COST of material for a major piping installation at General Electric Co.'s Appliance Park, Louisville, Ky., has been cut an estimated 50% by using unplasticized polyvinyl chloride rather than the Type 304 stainless steel originally considered for the job.

The corrosion-resistant P.V.C. piping carries room temperature deionized water with a 300 p.s.i. total head. Main lines are 2 in. and laterals are ¾ and 1½ inches. Injection molded P.V.C. fittings, manufactured by Tube Turns Plastics, Inc., 224 E. Broadway, Louisville 1, Ky., are used.

Foam in Australia

MANUFACTURE of elastic and rigid polyester foams will be started by Cable Makers Australia Pty. Ltd., Liverpool, N. South Wales, and S. A. Rubber Mills Ltd., Adelaide, S. Australia, in the near future.

The two companies are operating jointly in this endeavor under license from Farbenfabriken Bayer AG., Leverkusen, Germany.

Plastics in College

ENROLLMENT in a new series of plastic courses at the Newark College of Engineering, 367 High St., Newark 2, N. J., has been so great that the two sections originally scheduled have now been expanded to six, and three additional instructors have been added to the teaching staff.

The two courses, one on injection moldings and the other on compression moldings, have a registration of 90 executives and workers in the plastics industry from 29 companies in the northern New Jersey metropolitan area.

Molded Valves for Pipe

ADDITION of all-molded, seamless valves to its line of pipe, fittings, rods, blocks, sheets, and special fabrications has been announced by H. N. Hartwell & Son Inc., Park Square Bldg., Boston, Mass., distributor of Boltaron 6200 unplasticized polyvinyl chloride.

The valves were designed and engineered by The Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION

The Dow Chemical Co. will establish a wholly-owned subsidiary company, to be known as **Nederlandsche Dow Maatschappij N. V.,** in Rotterdam, Netherlands. The new company will build a plant, as well as tank storage, warehouse, and dock facilities, on a 50-acre tract. Among the products the firm plans to process are polystyrene, magnesium, alloys, and glycols.

The company will also supply technical information to assist the Dutch concerns and industrial customers in their manufacturing operations.

John Van Stirum, of Dow Chemical International's administrative staff, has been named manager of the subsidiary.

Resistoflex Corp., Belleville, N. J., announces plans to move into a completely modern new plant which will provide additional capacity for all of the company's products.

Edgar S. Peierls, president of Resistoflex, states that production capacity of its Fluoroflex-T hose assemblies will be doubled again for the third time since the products were introduced less than a year ago. One of the growing uses for Fluoroflex-T is in the propeller "feathering" systems of airplanes. Among prospective users in 1955 are atomic energy applications, jet aircraft, guided missiles and rockets.

Diamond Alkali Co. is modernizing and enlarging certain key facilities of its Research Center in Painesville, Ohio, at a cost of approximately $200,000 to meet the expanding needs of the firm's fundamental and applied research programs. The project calls for providing the additional space needed to take care of the company's exploratory efforts on new products and processes under the direction of **Dr. A. W. Meyer,** director of exploratory research.

The Research Center program includes the installation of a new radiation research laboratory for investigating potential applications of atomic energy for chemical applications. Other Diamond research groups to benefit will be alkali and electrolytic products, plastics, calcium carbonates, chlorinated organics, and chromates.

Minnesota Plastics Corp. has moved to a new 95,000-sq. ft. building at 45 E. Maryland St., St. Paul, Minn. The corporation was organized in 1939 and in 15 years has grown from a shop that contained one molding press and employed five people to a molding plant which now houses 24 injection molding presses, ranging in size from 4- to 80-oz. capacities, with an employment level of approximately 200 people.

The new plant has departments for tool making, assembly, painting, printing, drafting, engineering, and shipping.

Detroit Plastic Products Co. has constructed an injection molding plant at 35135 Groesbeck Highway, Mount Clemens, Mich., just a few blocks beyond the city limits of E. Detroit. The move will triple the company's plant capacity from a former capacity of 64 ounces.

Metasap Chemical Co., Harrison, N. J., a subsidiary of Nopco Chemical Co., has opened a new laboratory specially equipped with testing and research facilities. Metasap produces metallic soaps for various industries, including plastics. Among the new products to be developed will be stabilizers for vinyl resins.

Hungerford Plastics Corp., Rockaway, N. J., producer of flexible vinyl injection moldings, has purchased **Walsamer Inc.,** Riverdale, N. J., and will operate it as the Plastisol Molding Div. of the parent company. **Wallace Quackenbush,** former president of Walsamer, will manage the new division.

Plasticite Corp. 327 Rider Ave., New York 51, N. Y., has increased its injection molding capacity to the

THE PLASTISCOPE

extent that the company now has a 3-, 8-, 12-, and 16-oz. machine in operation. Plasticite now occupies an area of over 50,000 sq. feet.

Joseph Seliger has been appointed superintendent in charge of production.

Scott Testers (Southern), Inc. will erect a new plant in Spartanburg, S. C. Scott Testers (Southern) started operations in Spartanburg about two years ago as a Southern repair and service center for the equipment manufactured by Scott Testers, Inc., Providence, R. I.

Industrial Research Laboratories, manufacturing division of **Honolulu Oil Corp.**, is completing an expansion program for a new plant and equipment at 961 E. Slauson Ave., Los Angeles, Calif., involving over $100,000. The project will enable the company to meet changing material and design needs of its customers, as well as improve delivery schedules.

Industrial Research fabricates special cylinder liners under the trade name of XALOY.

Polo Plastics Co. has moved into a larger plant located at 1718 N. First St., Milwaukee, Wis., occupying 20,000 sq. ft. of manufacturing space. The company manufactures flexible plastic sheet home furnishings.

COMPANY NOTES

Koppers Co., Inc., Pittsburgh 19, Pa., announces the following appointments: **George H. Sollenberger** has been named coordinator of plastics market development of the Chemical Div. Mr. Sollenberger was formerly associated with Rohm & Haas Co. and Firestone Plastics Co. He had served as chief of the Thermoplastics Section, War Production Board, from 1942 to 1945 and as chief of the Thermoplastics Section, National Production Authority, from 1951 to 1952. **Dr. M. G. Sturrock**, who joined the company in 1948, has been appointed a research associate and group leader of the Central Staff Research Dept. **W. E. Kemp** succeeds Dr. Sturrock as manager of the Technical Dept., Tar Products Div. **Frank B. Varga**, associated with the company for 20 years, is now manager of the Chemical Div.'s Project Dept. For the past two years, Mr. Varga has been in Brazil, representing Koppers in plastics manufacturing operations conducted jointly by Brazilian interests and Koppers.

The Dow Chemical Co., Midland, Mich., announces the following promotions: **Dr. William H. Schuette** has been promoted to the position of assistant to the general manager of the Midland Div. He replaces **Dr. F. C. Peterson**, who has been named industrial relations director of the company. Dr. Schuette, who has been plastics production manager since 1952, began his career in the company's chemical engineering laboratory in 1941. A few months later he moved to styrene monomer production and in the succeeding years was variously associated with production of Styrofoam and Styron. **Max Key** succeeds Dr. Schuette as plastics production manager. He joined the company in 1928 and had been assistant production manager in charge of plastics production.

Continuing to expand its sales organization, Dow has opened a new field sales office at 925 Common St., New Orleans, La. **Glenn H. O'Neal**, formerly manager of the company's St. Louis, Mo., office, will manage the new office. This is the third field office established by Dow in 18 months—two others having been set up in Minneapolis, Minn., and Cincinnati, Ohio. The company now has 15 sales offices in major cities throughout the country.

The Borden Co.'s Chemical Div., 350 Madison Ave., New York, N. Y., has made the following appointments: **William L. Abramowitz** has been named a vice president of the division. He was formerly executive manager of Borden's Polyco Dept. in Peabody, Mass., known as American Polymer Corp. before the company acquired it in 1953. **Dr. Sidney Baum**, who has been in charge of the Production Dept. of the Peabody operation since 1945, is now general manager. **J. Spencer Brown III** has been appointed advertising manager. **Linwood A. Walters** has been named development manager of the Durite Div. and will make his headquarters in Philadelphia, Pa.

General Electric Co., Pittsfield, Mass., announces the election of Robert L. Gibson as vice president of the company and three appointments in the Plastics Dept. as follows: **G. Stanley Berge** has been named manager of marketing, **K. O. William Sandberg**, manager of engineering, and **Arthur T. Bourgault** became manager of the department's Taunton, Mass., custom molding plant.

Monsanto Chemical Co.'s Plastics Div., Springfield, Mass., announces that **Robert J. Schatz** has been appointed associate director of research; **Francis E. Reese**, associate director of engineering; **Luigi A. Contini**, formerly associate director of the Industrial Design Experimental Laboratory at Brooklyn's Pratt Institute, has joined the Market Development Dept. as assistant manager in charge of design research; and **John C. Garrels, Jr.**, production manager of the Plastics Div., has been granted a leave of absence to attend the spring session of the Advanced Management Program at Harvard University Graduate School of Business Administration.

National Vulcanized Fibre Co., Wilmington, Del., has opened a sales office in the Industrial Office Bldg., Newark, N. J. **Samuel Sinclair**, who has been associated with the company's New York office for nine years, will head the office.

National also reports that **Roy S. Fisher**, formerly branch manager of the Cleveland-Pittsburgh-Cincinnati territory, has been appointed sales manager for all divisions of the company. His headquarters will be at the home office in Wilmington. **James O. Otis** succeeds Mr. Fisher as manager of the Pittsburgh and Cleveland sales areas. The Cincinnati area has been organized under a separate office and will be headed by **R. F. Bauer**, the company's Cincinnati representative for 19 years.

Celanese Corp. of America's Plastics Div., 180 Madison Ave., New York 16, N. Y., announces the following changes in its Market Development and Sales Depts.: **Dr.**

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Controls viscosity which varies inversely with particle size. As much as 50% can be added, depending on viscosity requirement. Advantages: Reduces cost. Imparts opacity. Reduces shrinkage. Improves coloration. Non-abrasive.

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Aluminum. Lubricant, both internal and external.
Barium. Heat stabilizer for vinyls. High temperature molding.
Cadmium. Vinyl heat stabilizer of extreme clarity.
Calcium. Non-toxic lubricant.
Lead. Regular and dibasic. Heat stabilizer for opaque vinyls.
Lithium. High melting point internal lubricant.
Sodium. Valuable as a gelling agent in plastisols and organosols.
Zinc. Mold and internal lubricant.

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WITCO CHEMICAL COMPANY

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W. P. Moeller, who has been with the company since 1938, has been named manager of the Market Development Dept., replacing Dr. W. F. Holland who has resigned. **J. W. Flynn**, formerly director of sales, sheet, and molding compounds, succeeds Dr. Moeller as assistant manager of Market Development. **R. M. Leiter**, previously assistant director of sales, has been promoted to the post vacated by Mr. Flynn.

Celanese' Chemical Div. reports that **R. J. Werner**, former district sales manager of the Chicago office, has been appointed to the newly created post of assistant general sales manager. He will be responsible for all staff functions of the sales department, including the supervision of product managers.

Metal & Thermit Corp., 100 E. 42nd St., New York 17, N. Y., announces the following changes in its organization: **John B. Tinnon**, who has been with the company since 1924, has retired as chief sales executive but will remain with the firm as a consultant. **Donald K. Morgan**, formerly chief assistant to Mr. Tinnon, is now general sales manager. **O. L. Howland**, formerly manager of sales of the company's Welding Div., has been promoted to assistant to the general sales manager, with headquarters in East Chicago, Ind.

Ed. Jonasch, formerly development engineer with the United States Bureau of Aeronautics and lately with Allen Tool Co., Springfield, Ohio, has taken over the Plastics Tooling Section of Allen and established it as a separate company under the name of **Jonasch Plastics Co.**, Rear 235 N. Limestone St., Springfield, Ohio.

Continental Can Co., 100 E. 42nd St., New York 17, N. Y., announces the purchase of **Tenco, Inc.**, Winona, Minn., manufacturer of plastic pipe fittings. The Tenco line will become a part of Continental's Plastics Div.

Ohio-Apex Div., Food Machinery & Chemical Corp., has established a sales office at 2716 N. Broadway, Los Angeles, Calif. **Glenn A. Farno**, formerly of the Westvaco Chemical Div., will be in charge of the new office. Warehouse stocks of Ohio-Apex products are maintained locally.

Western Textile Products Co.'s Extruded Plastics Div., 2131 Hickory St., St. Louis, Mo., has increased its extrusion capacity and started operations in its own vinyl powder blending facilities with a control laboratory. **Jack D. Voelker**, formerly affiliated with National Lead Co., will be in charge of the operation.

The Carborundum Co., Niagara Falls, N. Y., has acquired **Curtis Machine Corp.**, Jamestown, N. Y. **Mr. DeMambro**, president and general manager of Curtis Machine since 1946, will continue in that capacity, reporting to **William H. Wendel**, vice president in charge of Carborundum's **Coated Abrasives Div.** in Wheatfield, N. Y.

Reed-Prentice Corp., Worcester, Mass., an affiliate of **Package Machinery Co.**, announces the promotion of **Lawrence A. Franks** and **Lebbeus S. Case** to the respective positions of purchasing agent and production planning manager. Mr. Franks succeeds Roy P. Harrington, who has retired after 42 years' service with the company and Mr. Case replaces Victor Rosenlund, who has retired after 47 years' service.

James H. Wolcott has been named Western sales manager, with offices at 4001 N. Elston Ave., Chicago, Ill. Mr. Wolcott will supervise sales of Reed-Prentice machines in Illinois, Wisconsin, and all states west of the Mississippi River.

United States Plywood Corp., 55 W. 44th St., New York 36, N. Y., has appointed **C. P. Setter** as executive vice president and **W. H. Hunt** as vice president in charge of sales. Mr. Setter has been the company's vice president in charge of production and a director since he joined U. S. Plywood in 1945.

Inta-Roto Machine Co., Richmond 23, Va., manufacturer of GM-1000 laminating and coloring machines, has signed a contract with **Erwin Kampf Maschinenbau** of Bielstein, near Cologne, Germany, to produce these machines for the European market and sterling area countries.

Erwin Kampf Maschinenbau is a producer of foil and film slitters, rewinders, and other machinery used in the printing and packaging industries.

Inta-Roto will also serve as exclusive distributor in the United States for foil and film slitters made by the European company.

Michigan Chrome & Chemical Co.'s Chemical Div., 8615 Grinnell St., Detroit 13, Mich., has established a new chemical laboratory for the development of new Miccro products and plastisols.

Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39, Calif., announces that it has taken over certain epoxy formulating activities of **Wal-Mar Plastics, Inc.** Wal-Mar will continue to manufacture and develop plastic tooling for the aircraft and automotive industries.

E & A Plastic & Metal Products, 4146 Pacific Way, Los Angeles 23, Calif., has established a new sales division to be known as **E & A Sales Corp.** The company manufactures and markets plastic pipe and pipe fittings from various plastics materials.

Officers of E & A are **Ed V. Alvarez**, president, and **John M. Elek. Ted Stevenson** has been named sales manager.

Lunn Laminates, Inc., Huntington Station, N. Y., has acquired **Ueber Tool & Mfg. Co.**, Detroit, Mich. The purchase of this facility marks the entry of Lunn into the tool and die industry. The company is now able to offer industry a complete tool and die service using all types of dies—steel, plastics, or a combination of plastics and steel.

Wallace & Tiernan, Inc., Belleville, N. J., announces that all operations formerly carried on by **W. C. Hardesty Co., Inc.**, a wholly-owned subsidiary of the company, will now be conducted by its **Harchem Div.**

Hale & Kullgren, Inc., 613 E. Tallmadge Ave., Akron, Ohio, has named **Wallace H. Woodrow** a vice president of the company and **Harry E. Tourtilotte**, a project manager. Mr. Woodrow, who joined the company in 1951 as chief engineer, is in

Crystal brush backs made from Lustrex Hi-Flow 55 are examined as they come from the mold. Note perfect clarity.

"WE CLIPPED 15 SECONDS off the cycle by changing to LUSTREX HI-FLOW 55!"

How Monsanto's soft-flowing styrene solved unusual problem for Autograf Brush & Plastic Company

In creating a new one-dollar line of crystal hair brushes, Autograf's first requirement was absolute clarity.

Toughness, freedom from strain and low cost were vital.

According to Autograf's production and development manager, the original materials tried on the job showed flow lines and often split under the tremendous stress needed to inset the nylon bristles.

"Because of the better moldability of Lustrex Hi-Flow 55, we got the perfect clarity we wanted. And as soon as we went into production, other advantages were also apparent.

"The Monsanto material flows about 20° cooler than the original compounds we used. It sets faster and we're clipping as much as 15 seconds off our 2-minute cycle. That's quite a saving. Needless to say, we're delighted."

For proof that Monsanto's soft-flowing styrene compound can improve the quality and sales appeal of the products you mold, try Lustrex Hi-Flow 55 on your next job. Write Monsanto Chemical Company, Plastics Division, Dept. MP-3, Springfield 2, Mass.

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Speed cycles and cut costs with HI-FLOW 55 MONSANTO LUSTREX Styrene Plastic

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charge of contract engineering. He was formerly associated with Monsanto Chemical Co. as a plant engineer. Mr. Tourtilotte had previously been with The Borden Co.'s Chemical Div. as plant engineer and manager.

J. G. Blew Co., 5242 San Fernando Rd., Glendale, Calif., has started operations as a fabricator of plastics molded parts. The operation will be headed by **Jesse G. Blew.** Mr. Blew was formerly in charge of the plastics department of Packard-Bell's television unit, and prior to that appointment, he was an executive of Walter L. Schott Co., Dauntless Engineering Co., New Plastics Corp., and F. E. Reinhold Co.

Plas Tex Corp., Springfield, Ohio, has appointed **Fore Associates, Inc.**, 550 Fifth Ave., New York, N. Y., as its Eastern representative.

Durable Formed Products, Inc., 6 Greene St., New York 13, N. Y., has named **M. W. Friedman Associates** its New England technical sales representative. Friedman Associates will solicit general plastic fabricating work and industrial material handling applications.

Kusan, Inc., Nashville, Tenn., has purchased **Auburn Model Trains, Inc.**, Auburn, Ind., which will operate under the name of **Kusan-Auburn, Inc.** Activities of the company will continue to be centered in Auburn.

Canadian Resins & Chemicals, Ltd., 600 Dorchester St. W., Montreal 2, Que., announces that **Kenneth B. Mathewson** has been appointed to the newly created position of assistant to the vice president. **George M. Hale**, formerly assistant manager of the firm's Industrial Products Div., succeeds Mr. Mathewson as manager of the division.

Catalin Corp. of America, 1 Park Ave., New York 16, N. Y., announces the election of **Joseph Hyman** as vice president and technical director of the company and the appointment of **Stanley Kordzinski** as chief chemist. Mr. Hyman, who joined Catalin in 1945, will be in charge of research and development, quality control, and technical service.

Plastics Color Co., 233 Broad St., Summit, N. J., is a newly formed organization which will supply the plastics industry with colorants. The company has purchased the **Colorblend Div.** of **Mid-America Plastics, Inc.**, and the addition of these facilities will make it possible to supply the industry with dry color for injection molding and extrusion and color pastes for polyester-fibrous glass fabrication. Standard colors will be stocked and a matching service for special colors will be offered.

Raymond Blake is head of the company. His former connections were with Plastic Molders Supply Co. as vice president and technical director; Catalin Corp. of America; and Drycol Div., Gering Products, Inc., as manager.

Schneider Industries, Inc. has purchased **Western Reserve Equipment Co.** and has combined the facilities of the two companies at 10522 Cedar Ave., Cleveland 6, Ohio. Schneider Industries specializes in the design and manufacture of special tools, machinery, and equipment.

Marblette Corp., 37-21 30th St., Long Island City, N. Y., supplier of phenolic and epoxy resins, has appointed **Acorn Adhesives Co.**, 678 Clover St., Los Angeles, Calif., and **Waldor Enterprises**, 3751 Hutchison St., Montreal, Que., as the company's representatives.

In addition to Marblette resins, Acorn handles its own industrial adhesives and cements, and is the West Coast distributor of plastics materials for several producers.

Waldor Enterprises, established in 1950 to serve companies in the reinforced plastics and related fields, is headed by **W. E. Wenninga**, who has been known in plastics tooling progress since 1943.

Lincoln Plastics Corp., 580 Fifth Ave., New York 36, N. Y., announces the opening of its new Eastern plant at 13 Marshall St., South Norwalk, Conn. The plant is equipped with a number of injection molding presses ranging from small automatic types to large preplasticizer-equipped types of 40-oz. capacity.

The executive offices in New York City will be moved to the Eastern plant on October 18.

Serge Abagoff, designer and developer of plastic toys and associated plastic items, has formed his own company, **Abagoff Products**, 5401 Satsuma Ave., North Hollywood, Calif., and will manufacture and distribute plastic toys, household, and specialty plastic items.

Mr. Abagoff heads the new firm as president. **Rudolph Fehrle** has been named production manager and **Ed Baird**, sales manager.

Quelcor, Inc., Front and Broomall Sts., Chester, Pa., reports the following appointments: **Richard J. Gollong** has been named vice president in charge of engineering and development; **Lea P. Warner**, formerly sales manager, is now assistant to the president; and **John R. Roberts** succeeds Mr. Warner as sales manager.

Prima Pipe Co., 1125 Second Ave., Scottsbluff, Neb., has been purchased by **John M. Dooley, Jr.**, formerly of Southwestern Plastic Pipe Co., and **William F. Dooley**, formerly of F. L. Jacobs Co. At the first directors meeting, John M. Dooley, Jr. was elected president; William F. Dooley, executive vice president; and **James Collopy** was appointed sales manager.

PERSONAL

R. F. Dettelbach has been appointed field sales manager of plastics materials; **W. E. Manring**, sales development manager; and **C. D. Segner**, manager of plasticizer materials of **B. F. Goodrich Chemical Co.**, Rose Bldg., Cleveland, Ohio, according to an announcement by **G. A. Fowles**, manager of the Plastic Materials Sales Dept.

R. F. Dettelbach

Mr. Dettelbach, formerly Eastern sales manager of the company's New York City office, will move to the Cleveland headquarters. He will be in direct charge of all field sales, with each salesman reporting di-

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Standard sizes are furnished in 20" x 20" from 1/32" to 1" thick and 24" x 24" from 1/16" to 1/2" thick. Special sizes are also available. Polyethylene, Polystyrene, Tenite, Saran, Vinylite, Geon, Ethyl-Cellulose, Styraloy, and Nylon sheets can be compression molded in most of the above sizes.
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rectly to him. He joined B. F. Goodrich Co., Akron, Ohio, in 1944 as a technical service engineer; he was transferred to BFG Chemical in 1945 and was made a sales representative in the New York area. In 1952 Mr. Dettelbach was appointed Eastern sales manager of plastics materials.

Mr. Manring will direct market development work for new plastics and applications. He joined the company in 1948 as a technical service engineer at Avon Lake, Ohio, and subsequently held various other positions with the organization until 1954 when he was named technical service manager.

Mr. Segner will head sales for plasticizers used in the manufacture of plastics. He joined BFG in 1937 as a chemist in the general laboratories in Akron, Ohio, and in 1939 he became a member of the research group on polyvinyl chloride resins.

John McE. Sanderson, after 23 years of service, has retired from **American Cyanamid Co.,** 30 Rockefeller Plaza, New York 20, N. Y. Assistant to the general manager of the Plastics and Resins Div. since July 1953, Mr. Sanderson has been associated with the development of resins for the paint and plastics industries for over 40 years. Mr. Sanderson intends to remain active in the paint and plastics industries on an independent consulting basis.

Alvon R. Cox has been appointed technical manager of plastisol and bulb products at Plant 4 of **The B. F. Goodrich Co.'s** Industrial Products Div., Akron, Ohio. He was formerly manager of latex foam development of the research and development laboratory at American Anode, Inc., now a part of BFG's Industrial Products Div.

Vincent McCarthy is now sales manager of polyethylene resins of **U. S. Industrial Chemicals Co., Div. of National Distillers Products Corp.,** 99 Park Ave., New York 16, N. Y. Mr. McCarthy was formerly sales manager of extruded polyethylene products of Gering Products, Inc., Kenilworth, N. J.

Alfred W. Hanmer, Jr. has been appointed to the newly created post of director of sales and advertising

of **Durez Plastics & Chemicals, Inc.**, North Tonawanda, N. Y. He will have complete charge of all sales and advertising activities of the company. Mr. Hammer joined the Durez sales organization in 1929; in 1936 he was named sales manager and was elected a vice president of the company in 1945.

Dr. Alvan H. Tenney has been appointed to the newly created post of manager of market research of **Carbide and Carbon Chemicals Co., a Div. of Union Carbide and Carbon Corp.** Dr. Tenney will assist **Dr. R. L. Bateman,** who was recently named director of product development.

J. E. Mayl, vice president and general manager of **The Goodyear Tire & Rubber Co.'s Films, Foam, and Flooring Div.,** was guest of honor at recent ceremonies for his completion of 30 years' service with the company. Associated with the rubber industry since 1911, Mr. Mayl has been with Goodyear since 1924 when he joined the company as a member of the Truck Tire Sales Dept. in Akron, Ohio.

W. O. Edwards has been named superintendent of industrial and public relations of the Chesterfield plant of **National Aniline Div., Allied Chemical & Dye Corp.,** Hopewell, Va. Mr. Edwards joined National Aniline's Polyamide Project in October 1953.

J. Gilbert Mohr has joined **Process Development Co., Inc.,** Genoa, Ohio, as general manager. He was formerly quality control manager of Fiber Glass Div., Libbey-Owens-Ford Glass Co., Parkersburg, W. Va.

James H. Christopher, Jr. has been appointed New England representative of **American Resinous Chemicals Corp.,** Peabody, Mass.

Robert G. Baumann, former sales manager of silicone products of General Electric Co.'s Chemical Div., has been elected a principal associate of **Cresap, McCormick & Paget,** 342 Madison Ave., New York, N. Y., management consultants.

Joseph R. DeFilippis has joined **Lupoline Automatic Polishing Equipment Corp.,** 99-111 Columbus Ave., Tuckahoe, N. Y. He will have full charge of the machine and assembly shop producing Lupoline

(*To page* 248)

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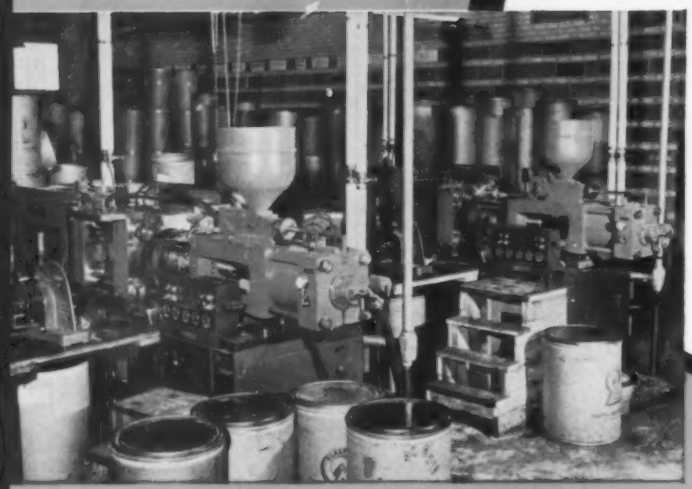

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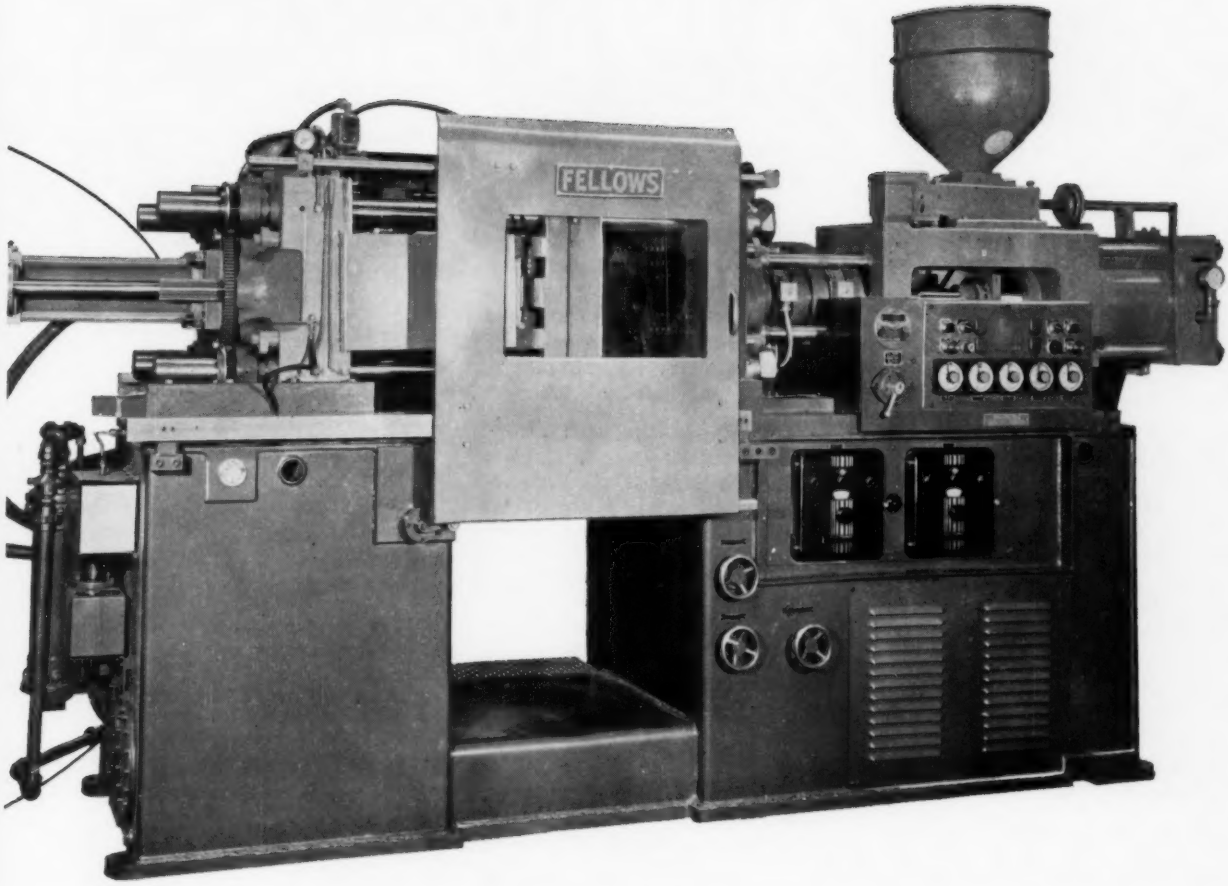

In one of New York's leading molding shops... where production schedules are tight, the variety of work great and mold changes frequent...they have piled up impressive evidence of the Fellows "6-200" productivity and versatility.

Besides the many advantages of a full 6-ounce shot when needed, other modern machine features such as stroke length adjustment on both press and injection ends permit small high speed machine productivity for light shots...dry run speeds of 490 to 650 cycles per hour being obtainable. Prepack and pre-position device (optional) brings plunger half-way forward during press dwell before injection...providing for increased speed and pressure transmission and up to 8 oz. shots.

In fact, for manual operation of troublesome molds or full automatic operation of the better tools, the rugged construction, ease and speed of set-up and change over, simplified die clamping, large mold area and room between safety doors for auxiliary knock out or core pulling cylinders makes this machine a pleasure to tool. Shipped as a complete package...ready to go to work...just connect power, water and drain. These are only a few facts. Don't miss getting the whole story from the Plastics machine specialist at any Fellows office. It can mean real money to you.

injection molding equipment

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THE PLASTISCOPE

tumbling machines and tools for the plastics industry. Joseph Lupo will supervise the firm's research and development laboratories.

S. Sydney Minault has been named general manager of **National Research Corp.'s Equipment Div.,** 70 Memorial Dr., Cambridge 42, Mass. Mr. Minault has previously served as production manager and later vice president and general manager of Tracerlab, Inc.

Dr. Edwin L. Lotz, formerly research director of Minnesota Mining & Mfg. Co.'s Irvington Varnish & Insulating Div., has been named general manager of **Glass Fabrics Finishing Corp.**, Industrial Village, Cedar Grove, N. J.

At the same time Dr. Lotz was appointed general manager, it was announced that **Hess, Goldsmith & Co., Inc.,** 1400 Broadway, New York, N. Y., had acquired full ownership of Glass Fabrics Finishing Corp. from Waldrich Co., Delawanna, N. J., with which it had previously shared ownership.

Clinton M. Anderson has been named sales manager of **Chemical Products Corp.'s** Textile and Novelty Coatings Div., King Philip Rd., East Providence, R. I.

Milton W. Stein has been named Chicago representative of **Toscony Fabrics, Inc.,** 303 Fifth Ave., New York, N. Y., for its line of printed Krene film and Filmtex. Mr. Stein, who replaces A. E. Kleine, will be located at 110 S. Dearborn St., Chicago, Ill.

Harry G. Hoehler has joined the New York sales staff of **Witco Chemical Co.,** 260 Madison Ave., New York, N. Y., and will handle the sales areas in Philadelphia, Pa., and Baltimore, Md.

Paul S. Hess has been named technical director of **General Plastics Corp.,** Paterson, N. J. His responsibilities will include the development of new plastics coatings supplementing the custom applications of Teflon and other protective coating specialties in which General Plastics is a specialist. Mr. Hess will also supervise the development of resins and plastics for use in casting, laminating, and encapsulating work. He was formerly connected with National Lead Research Laboratories and Congoleum-Nairn as senior chemist in the research division.

Eugene A. Glasser has been appointed executive vice president in charge of manufacturing operations of **Russell Reinforced Plastics Corp.,** Lindenhurst, N. Y. His assistant will be **Warren Amendola.**

Andrew Rapas has been named manager of the Trenton, N. J., plant of **St. Regis Paper Co.'s Panelyte Div.** Mr. Rapas joined the organization in 1930.

Charles F. Pfeifer has been appointed president and general manager of **Visible Package & Paper Corp.,** 439 Fourth Ave., New York, N. Y. His former affiliations were with Olin Mathieson Chemical Corp's Film Div. as direct sales manager, U. S. Rubber Co., Newton Falls Paper Co., and Plastic Firm Corp.

E. Robert Lucas is now sales manager of **Thomas Mfg. Corp.'s** newly created **General Merchandise Div.,** 80 Clinton St., Newark 5, N. J. This division is a new department of the firm and will market such products as drug sundries, gift items, hardware, housewares, and notions.

C. Gordon Jelliffe has been named vice president in charge of industrial sales of **Columbus Coated Fabrics Corp.,** Columbus 16, Ohio. Mr. Jelliffe, who joined the organization in 1940, was formerly sales director of Columbus' Col-O-Vin Vinyl Products Div.

Norman R. Davis, formerly chief engineer of **Majestic Molded Products, Inc.,** 845 E. 138th St., New York 54, N. Y., is now vice president and general manager of the company.

Deceased

Meyer Goldman, manager of the Quality Control Dept. of **The Visking Corp.'s Plastics Div.,** Terre Haute, Ind., died at the age of 41. Mr. Goldman had joined the company in 1941 as a chemist, later serving as supervisor of the Analytical Testing Section of the Central Laboratories. Last year he was named manager of the Quality Control Dept.

MEETINGS

March 14-18—American Society of Tool Engineers, Twenty-third Annual Meeting and First Western Industrial Exposition, Shrine Auditorium, Los Angeles, Calif.

April 4-7—American Chemical Society, Div. of Paint, Plastics, and Printing Ink Chemistry, Cincinnati, Ohio.

April 6-10—World Plastics and Trade Exposition, National Guard Armory in Exposition Park, Los Angeles, Calif.

April 13-15—The Society of the Plastics Industry, Inc., S.P.I. Pacific Coast Section Conference, Palm Springs, Calif.

April 16-17—Packaging Machinery Manufacturers Institute, Semi-Annual Meeting, Palmer House, Chicago, Ill.

May 1-4—American Institute of Chemical Engineers, Meeting, Shamrock Hotel, Houston, Texas.

May 7-15—The Society of the Plastics Industry, Inc., 1955 Annual Conference, Convention Cruise aboard Queen of Bermuda to Havana, Cuba, and Nassau, B.W.I.

May 14-22—ACHEMA XI, Chemical Plant and Apparatus Exhibition and Congress, Frankfurt am Main, Germany. Sponsored by Deutsche Gesellschaft fur Chemisches Apparatewesen (DECHEMA). Additional information may be obtained from the Chicago Section of the American Chemical Society, 86 E. Randolph St., Chicago, Ill.

May 18-19—The Chemical Market Research Association, Annual Meeting, Hotel Plaza, New York, N. Y.

May 31-June 3—Third Basic Materials Exposition, Convention Hall, Philadelphia, Pa.

S.P.E. Meeting

March 9—Society of Plastics Engineers, Newark, N. J., Section, Military Park Hotel, Newark, N. J. The meeting will consist of a panel discussion on thermoplastic sheeting.

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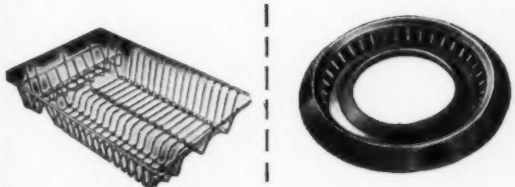

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MACHINERY and EQUIPMENT FOR SALE

HYDRAULIC PRESSES: 1—Erie Belt Press, 4242 Tons, 2—8" openings, 18'-0" x 52" steel steam platens, 6 rams—30" dia. x 16" stroke; 1—Birdsboro, 2000 Tons, down-acting ram 34" dia. x 14" stroke, 48" DLO, 42" x 42" bed area; 1—Farrel, 1000 Tons, 2—6" openings, 42" x 42" steel steam platens, ram 36" dia. x 12" stroke; 1—HPM, 750 Tons, down-acting, ram 28" dia. x 43" stroke, 72" DLO, 59" x 44" bed area, MD Low and High Pressure Pumps and Accumulator System; 1—Erie, 700 Tons, 2—7" openings, 38" x 38" steel steam platens, ram 30" dia. x 17" stroke; 1—Baldwin-Southwark, 400 Tons, slab-side, 30" x 30" steel steam platens, 23" DLO, ram 21" x 17" stroke; 1—Farrel, 393 Tons, 48" x 48" steam platens, 2—15" openings, 4 rams 10" dia. x 24" stroke, approx. 15" per opening; 1—Farrel, 200 Tons, 2—6" openings, 36" x 36" steel steam platens, ram 16" dia. x 11" stroke; 1—Watson-Stillman, 110 Tons, 15" x 15" steel steam platens, 10" DLO, ram 8½" dia. x 9" stroke, MD Pump; 1—Watson-Stillman, 100 Tons, down-acting ram 11½" x 9½" x 6" stroke, 22" x 20" bed, 24" DLO, self-contained, 15 HP MD Vickers Pump. Unit practically new; 1—Watson-Stillman, 100 Tons, 11¾" x 12" platens, 22½" DLO, ram—8" dia. x 15" stroke, complete with 3 HP MD Pump; 1—HPM, 100 Tons, 18" x 18" platen area, ram—8" dia. x 18" stroke, 30" DLO, steel cylinder—4000 PSI; 1—HPM, 35 Tons, down-acting ram 6" dia. x 6" stroke, 15" DLO, 12" x 6" bed area, self-contained; 2—Watson-Stillman Laboratory, 30 Tons, 6 ½" x 9 ½" electrically heated platens, integral hand pumps. INJECTION MOLDING MACHINES: 1—Plasticor Vertical 2 oz; 1—HPM Horizontal Model 54, 2 oz; 2—Reed-Prentice, 2 oz; 1—Watson-Stillman, 2 oz., Frame suitable up to 6 oz; 2—HPM Model 200-H, 9 oz; 2—Lester, 12 oz. and 20 oz; 2—Impco Model VF-822A, 22 oz. EXTRUSION MACHINES: 1—MPM, 1951, 3 HP Sterling Speed-Trol Drive; 2—MPM, 1951, 40 HP M.D.; 1—MPM Pelletizer, 95% New, Capacity up to 1000 lbs. per hour; 1—Royle No. 1, Rubber, 5 HP M.D. MISCELLANEOUS: Baker-Perkins Mixer, Lab Size 6, Class BB, Sigma Blades, Jacketed Body, arranged for Motor Drive. Banbury No. 1, Completely Chrome Plated Interior for Plastics, 50 HP Motor Drive, Oil Heating System, All Controls. Stewart Bolling 6" x 12" Lab Mill, 5 HP, MD, Safety Brake. Ball & Jewell Midget, Stainless Steel, 1 HP MD Rotary Cutter. Other sizes and makes of Plastics and Rubber Extruders; also Mills, Calenders, Mixers, Grinders, Pumps, Valves, Platens, etc. JOHNSON MACHINERY COMPANY, 683 Frelinghuysen Avenue, Newark 5, New Jersey, BIgelow 8-2500. What Have You For Sale? What Are You Looking For?

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Mitts & Merrill 15CD Rotary Cutter. J. H. Day, from ¾ up to 100 gal., Imperial and Cincinnatus D.A. Jacketed, Sigma Blade Mixers. Day 15 to 10,000 lbs. Dry Powder Mixers. Baker Perkins Heavy Duty Steam Jacketed, Double Arm, from 5 to 200 gal., Mixers (Unidor and Vacuum also). Gemco 2000 lb. 56 cu. ft. Double Cone Blender. Mikro Bantam 1SH, 2TH, 3W, 4TH Pulverizers, Rotex, Tyler Hum-mer, Robinson, Raymond, Gayco, Great Western Sifters. Colton 2 RP and 3 RP Rotary & #5½ Tablet Machines. Carver Laboratory 20 ton hydraulic Press. Package Machy. FA, FA2, FA4, U4, Miller, Hayssen, Wrap-King, Scandia, Oliver Auto. Wrappers—all sizes. This is only a partial list. Over 5000 machines in stock available for immediate delivery. Tell us your machinery requirements.
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318-322 Lafayette St., New York 12, N.Y.

FOR SALE: Injection Presses: 8, 12, 32 oz. Reed, 6, 12 oz. Lester, 9, 16, 40 oz. HPM, 1 oz. Van Dorn, 6 oz. Lewis, 4 oz. Impco. Extruder Conveyors. Scrap grinders. Ovens. Compression & Transfer presses: 50, 100, 250, 600 tons. Preform press Stokes 280 C. 42" Slitting & Rewind mach. Big Fiberglas press & oven. 1000 Ton Elmes Hobbing press. Read 6 qt. mixer. Equipment to be inspected in operation. List Surplus Equipment with me. JUSTIN ZENNER, 823 Waveland Ave., Chicago 13, Ill.

KUX 2½" dia. Single Punch Preform Machine. Leominster 8 oz. & Van Dorn 1 oz. Injection Molding Machines. Plastic and Rubber Equipment. Farrell 16"x48", 15"x36" and 6"x12", 2 roll mills. Mills and Calenders up to 84". New Seco 6"x12" and 6"x16" Lab. Mixing Mills and Calenders. Rubber & Plastic Extruders. Wat.-Stillman 75 ton automatic Molding Press 20"x20" platens. 200 ton Hobbing Press 18"x 14" platens. HPM 200 ton 30"x48" Platens. New Loomis 340 ton, 24"x56" platens. 200 ton Brunswick 21"x21" platens, 14" Ram. Southwark 30 ton 14"x14" platens, semi-auto. 150 Ton Bolling 20"x20" platens. Also Lab to 2000 tons from 12"x12" to 48"x48". Hydr. Oil Pumps. Gould 75 HP motor Dr. 2 stage Centrif. Pump 250#. W.S. 4 Plgr. High and Low Pressure Hydr. Pump. Elmes Hor. 4 Plgr. 4500 lbs. and 5500 lbs. Hydr. Accumulators. Stokes Automatic Molding Presses. Rotary & single Punch Preform Tablet Machine ½" to 4". Injection Molding Machines 1 oz. to 32 oz. Baker Perkins Jacketed Mixers. Plastic Grinders. Heavy duty mixers, gas boilers. Partial listing. We buy your surplus machinery. STEIN EQUIPMENT CO., 107-8th Street, Brooklyn 15, N.Y., STerling 8-1944.

FOR SALE: 32 oz. Lester, 32 oz. H.P.M., 60 oz. H.P.M., 48 oz. Lester, $45,000. 48 oz. DeMattia, new 20 oz. Lester, new 1950, $16,000. 16 oz. H.P.M., 1952 16 oz. Reed-Prentice, 1953. 12 oz. Lester, 1946, $7,000. 12 oz. Crown Moldmaster, $10,500. 12 oz. Watson-Stillman, excellent. 9 oz. H.P.M., $5,500. 8 oz. Fellows, 1948, $7,500. 8 oz. Reed-Prentice, double link, $6,000. 8 oz. Lester, 1949, $7,500. 8 oz. Leominster, $5,000. 6 oz. Reed-Prentice, $3,500. 6 oz. Lester, $4,000. 4 oz. Reed-Prentice, 1949, $4,750. 4 oz. Lester, 1949, $5,500. 4 oz. Impco, $8,000. 4 oz. Lester, $3,000. 4 oz. Lester vertical, $4,500. 3 oz. Fellows, $6,500. 2 oz. Watson-Stillman vert. almost new. Ball & Jewell Cumberland scrap grinders. 6 Tray Preheating ovens, $150. each. #235-A Stokes press. 80 ton Transfer & Compression press, brand new, $4,250. 3" cap. Extruder. New Italian make extruders. ACME MACHINERY & MANUFACTURING CO., 102 Grove Street, Worcester, Mass.

FOR SALE: 16 oz. HPM Injection Press. 1952 model—delivered in early 1953. Like new—under six months total usage. Ready for immediate shipment. Can be seen running. Reply Box 34555, Modern Plastics.

FOR SALE: BARGAIN PRICED 12 oz. Watson-Stillman injection presses—approximately 7 years old—excellent msintenance—topnotch condition—anxious to sell. Reply Box 34655, Modern Plastics.

FOR SALE: 1—F.B. 32"x92" inverted-L 4 Roll Calender, reduction drive, d.c. vari-speed motor; 1—Royle #4 Extruder, motor driven. 1—6"x12" Laboratory Mill, m.d. 1—Ball & Jewell #2 Rotary Cutter, 15 h.p. motor. 3—#28 Devine Vac. Shelf Dryers, 19—59"x78" shelves, complete. 3—Colton #5½ single punch Cabot machines, m.d. 1—Read-Standard 2000 lb. steel horizontal mixer. 1—Farrel 20"x22"x60" mill, top cap frame, falk reduction drive, 100 h.p. motor. 2—Farrel 16"x42" Mills with reduction drive and 100 h.p. motor. 4—Hymac 125 ton Molding Presses, 16"x16" electrically heated platens. Also other sizes; Hydraulic Presses, Tubers, Banbury Mixers, Rotex Screens, Mills, Vulcanizers, Calenders, Pellet Presses, Cutters. Send us your inquiries. What have you for sale? CONSOLIDATED PRODUCTS CO., INC., 50 Bloomfield Street, Hoboken, N. J. HOboken 3-4425. N. Y. Tel.: BArclay 7-0600.

FOR SALE: Stainless Steel Rotary Dryer, Link Belt Co., 5'2"x16', No. 502-16, with all auxiliary equipment. Roto Louvre type. Reply Box 34355, Modern Plastics.

FOR SALE: Hobbing Press 800 Ton W.S. (2) 300 Ton W.S. Presses 20x20 & 29x24 Platens. 140 Ton W.S. 22x16 Platen. 85 Ton Waterbury Farrel 20x24 Platen. 63 Ton Press 15x15 Platen with Pullback Cyls. 9, 8, 4, Oz. Injection Molding Machines. 15 Ton Lab. Presses 10x8 Platen. 10 Ton Lab. Presses 6x6 Platen Ball & Jewell Plastic Grinders. Standard Mystic Embossing Presses. Accumulators, Pumps, Valves. Many other Presses—Send For Bulletin. AARON MACHINERY CO., INC., 45 Crosby St., New York 12, N. Y. Tel. WAlker 5-8300.

1—STOKES 200 Ton Hydraulic, Single Punch Press 10"x6" preform x5" depth of fill.1—National 10"x20" two roll Mill with 25 HP motor; 1—Baker Perkins 100 gal. S.S. double arm jacketed Vacuum Mixer; 2—Baker Perkins, Readco 100 gal. Jacketed double arm Mixers; 1—Baker Perkins 50 gal. double arm jacketed Mixer 50 HP motor; 4—Stokes Rotary Preform Presses DD2, DDS2, D4 and D3; 1—Kux Model 15-25 double action Rotary Press; Also: Sifters, Cutters, Banbury Mixers, etc., partial listing; write for details; we purchase your surplus equipment. BRILL EQUIPMENT CO., 2407 Third Ave., New York 51, N. Y.

1" NRM PLASTIC LAB EXTRUDER electrically heated. One RC 100 Windsor twin screw extruder. 2½" NRM Extruder oil heated. 3½" Hartig extruder oil heated. #1½ Ball and Jewell Cutter. 200 Ton Elmes Compression Molding Press 27½" x 26" platens 30" daylight with pushback cylinders. Reply Box 33155, Modern Plastics.

FOR SALE: New Imported Extruders. Latest developments, self contained. Moderately priced. For details write or call. ACME MACHINERY & MANUFACTURING CO., 102 Grove Street, Worcester, Massachusetts. Phone: Pleasant 7-7747.

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(5) NEW WATSON-STILLMAN EJECTION Molding Heating Chambers, one four ounce, one six ounce, two eight ounce, one sixteen ounce. Price one third the cost of new. New 75 ton presses, size 22x22, 10" ram, 10" stroke, $1100 each, ten day delivery f.o.b. Brooklyn, New York, one or more can be obtained. HYDRAULIC SAL-PRESS CO., INC., 388 Warren Street, Bklyn., N. Y.

INJECTION MACHINES FOR SALE: 2, 4, 6, 8, 10, 12, 16, 24 and 32 oz. Reed-Prentice; 2, 4, 9 and 16 oz. HPM; 4, 8, and 12 oz. Lester; 4, 8 and 22 oz. Impco; 12 oz. DeMattia; 2 oz. Van Dorn; 4 and 12 oz. Watson-Stillman; 15 oz. Crown and 8 oz. Leominster. Machines can be inspected in operation. Reply Box 34955, Modern Plastics.

FOR SALE: 2—400 ton compression molding presses; 2—Ball & Jewell cutters, No. 2, No. 1½; 2—Stokes Model 294 Preform presses, 4" tablets; 1—Colton 5½ piece Preform press; 2—Plastics extruders, 2½", 3¼"; also mixers, mills, presses, et cetera. CHEMICAL & PROCESS MACHINERY CORP., 148 Grand Street, New York, N. Y.

FOR SALE: 20 oz. Lester-Phoenix Injection Molding Press (new 1951); 12 oz. Watson-Stillman Injection Molding Press; 50 Ton Model 235 Stokes Press; (2) 15 Ton Model 200 D3 Stokes Presses; 3 & 5 HP Vickers Pumping Units; G-8 Porter Cable Belt Sander; 150 Ton Baldwin-Southwark Hydraulic Press; JOHN F. CARSON, A & Venango Sts., Phila. 34, Pa. GArfield 6-2221.

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CLASSIFIED ADVERTISING

(*Continued from page 250*)

FOR SALE: LATE 1951 MODEL—16 oz. HPM press. Very reasonably priced—good condition—well maintained—available immediately—Can be seen in operation—A real bargain for the right party. Reply Box 34755, Modern Plastics.

MACHINERY FOR SALE—16 oz. HPM—Excellent Condition—can be seen in operation. Reply Box 32255, Modern Plastics.

FOR SALE
Lester 3S-27-12 Injection Molding Machine 12 ounce capacity. Excellent running condition, can be seen in operation.
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WANTED: Used Foremost grinder, 3 or 5 or 10 H.P., also Cumberland notched knife dicer. Reply Box 36055, Modern Plastics.

WANTED: 2½" NRM OIL HEATED EXTRUDER. Please describe condition, type of screw and furnish price in reply.
Reply Box 35355, Modern Plastics.

WANTED: Machinery including Rubber Mills, Hydraulic presses, Study mixers, Calenders, Banbury mixers, Pulverizers, Grinders, Rotary cutters, Extruders, Screens, Injection Molding machines, Dryers. Will purchase complete plant. CONSOLIDATED PRODUCTS CO., INC., 50 Bloomfield Street, Hoboken N. J. HOboken 3-4425, N. Y. Tel.: BArclay 7-0600.

WANTED: 54" or 60" plastic mill steam generator or boiler for above mill and pelletizing or dicing machine. Reply Box 35955, Modern Plastics.

WANTED: 150 Ton Molding Press, Stokes R4 Preform Press, 8 oz. Injection Molding Machine, No. 3 Banbury Mixer, Calender, Extruder. Give particulars. Reply Box 34455, Modern Plastics.

MATERIALS FOR SALE

FOR SALE: 20,000 lbs. low priced Reground Acrylonitrile Copolymer, for plating applications, etc.; 5,000 lbs. Metallic Silver Reprocessed Polystyrene Pellets; 20,000 lbs. low priced Black Cellulose Acetate; Large variety Bright colors Acetate and Butyrate Pellets. All at low prices. Samples on request. A. BAMBERGER CORPORATION, 703 Bedford Ave., Brooklyn 6, N. Y., Tel.: MAin 5-7450.

FOR SALE: 20,000 lbs. each Red and Blue Styrene Pellets. Surplus lot Red Acetate Pellets—15,000 lbs. Both attractively priced. We are also in the market for all surplus plastic scrap and powder. PLASTIC MOLDING POWDERS, INC., 2004 MacDonald Avenue, Bklyn., N. Y. Tel.: ES 5-7943.

ODD LOT—50,000 lbs. Standard Plasticizer for Ethyl Cellulose, Cellulose Acetate, Vinyls—19.5¢ per pound. Contact us for details. ACETO CHEMICAL CO., INC., 40-40 Lawrence St., Flushing 54, N. Y. INdependence 1-4100.

FOR SALE: 5,000 lbs. Pink Reprocessed Butyrate 30¢ per lb; 5,000 lbs. Black Reprocessed Butyrate 25¢ per lb.; 12,000 lbs. Reground Assorted and Mixed 20¢ per lb.; colored Butyrate 8,000 lbs. Clear Cellulose Acetate Pellets M H Flow 35¢ per lb. Reply Box 35055, Modern Plastics.

MATERIALS WANTED

WANTED: Plastics Scrap and Rejects of all kinds, ground and unground. Also rejected molded pieces and surplus virgin molding powders. Top prices paid. A. BAMBERGER CORPORATION, 703 Bedford Ave., Brooklyn 6, N. Y., Tel.: MAin 5-7450.

WANTED: Plexiglas and Lucite scrap, salvage and cut-offs, any quantity. DUKE PLASTICS CORP., 406 Atlantic Ave., Bklyn. 17, N. Y. ULster 8-9413.

INTERESTED IN PURCHASING odd lots of resin and off resin. Any quantity, large quantities preferred. Reply in detail sending samples and identify material offered. Reply Box 32955, Modern Plastics.

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SELL US YOUR PLASTIC SCRAP. Polyethylene, Polystyrene, Acetate, Ethyl Cellulose, Acrylics, Butyrate, Nylon. GEORGE WOLOCH, Inc., 82 Beaver St., New York 5, N. Y.

MOLDS FOR SALE

MATCHED METAL STEEL DIES to produce fiberglass reinforced plastic bathtub size 4'6" x 15" deep x 27" wide. Dies cost $15,000 originally. Since we are custom molders, we are not in a position to market bathtubs. Priced for quick sale including preform screen—$5,000. Dies guaranteed in excellent condition. MOLDED FIBERGLASS CO., Ashtabula, Ohio.

FOR SALE: A-1 condition, production molds on current syndicate listings on the following: Toys: Ranger Men w/Shooting Gun, Clicker Pistols, Toy Binocular, Notions: Clown Ear Muffs, three types of Sewing Kits. Stationery: Pencil Box. Household: Flower Pots. Above reasonably priced for quick sale. Samples and further information on request. Box 33255, Modern Plastics.

FOR SALE: Single cavity mould for toilet seat lid. Single cavity mould for toilet seat. Tool steel semi-automatic. T. K. MANUFACTURING COMPANY, INC., Box 116, Ava, Missouri.

MOLDS WANTED

WE ARE PURCHASERS of injection moulds in good condition for European market. Offers with samples, size of moulds, number of prints, prices . . . for the following items: toys, novelties, advertising goods, kitchen and household utensils, brushes, stationery, school furniture. Wanted also exploitation of patents, licenses, close cooperation with foreign firms. FRANCE MACHINES, Département Plastiques, 13 Bd. des Brotteaux, Lyon. (France)

ENGLISH MANUFACTURER visiting U.S.A. in March seeks contacts with Manufacturers for exchange and/or purchase of Injection Moulds for 2, 4, 6, and 8 oz. Machines. Is mainly interested in Fancy Goods, Haberdashery Lines, Hair Ornaments, Jewelry, Notions. Reply Box 32155, Modern Plastics.

PLANTS WANTED

WANTED POLYETHYLENE FILM MANUFACTURING PLANT: Will buy interest in plant for production and sales of Polyethylene seamless tubing and film. Desires Eastern location. Personnel must be aggressive and have thorough experience in manufacturing techniques and be ready for fast growth with added capital. Reply Box 30655, Modern Plastics.

EXTRUSION AND VACUUM FORMING PLANT WANTED: A large plastic molder will furnish capital and sales organization for expanding Styrene extrusions and vacuum forming. Prefers location in Midwest area. Desires plant sufficiently staffed for rapid expansion. Reply Box 30555, Modern Plastics.

WANTED: Modern Plastics Injection Molding Plant. Metropolitan New York area preferred. Consider partnership. Write details. All replies confidential. Reply Box 33555, Modern Plastics.

PLANT FOR SALE

FOR SALE: Medium size modern plant (approximately 6200 square feet) producing reinforced and vacuum molded products. Now producing custom molded products—also producing and marketing our own established line. Reply Box 33355, Modern Plastics.

HELP WANTED

CHEMIST OR
CHEMICAL ENGINEER
with experience in Polyester—Fiberglas and related laminates. Fine opportunity with expanding corporation.
LURIA-COURNAND, INC.
Havre de Grace, Maryland

POLYETHYLENE FILM ENGINEER: Experienced in the manufacture of extruded seamless tubing and film. Large plastic fabricator wants to expand into that field. Wonderful opportunity for right man with a thorough background experience capable of setting up small modern production plant designed for rapid growth. Send full resume of qualifications and experience. Reply Box 30355, Modern Plastics.

VINYL FLOORING CHEMIST
Leading flooring manufacturer has position available for chemist experienced in compounding and processing vinyl flooring or allied products. Experience in rubber compounding helpful, but not essential. Excellent opportunity for right man. Write giving full particulars regarding age, experience, education and salary expected. All replies held in strictest confidence. Our employees know of this advertisement. Reply Box 31955, Modern Plastics.

PLASTICS MATERIALS MANUFACTURER WANTS experienced salesman for Chicago and Middle Western Territory. Must be capable buyer, seller and trader of Virgin and Scrap materials. Send complete resume stating salary required. Reply Box 35855, Modern Plastics.

SALES REPRESENTATIVE. Growing midwestern concern seeking experienced man in Fluoro-carbon compounds. Chemical education desirable. Capable of developing and handling industrial accounts. Real opportunity with unlimited territory. Permanent connection. Salary and expenses. Reply should give complete details of education and experience. All inquiries held confidential. Reply Box 34855, Modern Plastics.

EXTRUSION AND VACUUM FORMING ENGINEER: To set up and operate custom production facilities in Styrene sheet. To locate in Midwest near potential volume production center. Reply Box 30455, Modern Plastics.

EXTRUSION OPERATOR
Set-up man with wide experience to assist supervisor in long established extrusion plant New York City. Will help relocate. Reply Box 31755, Modern Plastics.

PLASTIC FILM—SALES & PRODUCT DEVELOPMENT. Unusual opportunity for two technically trained men to play direct part in growth of new product line of well-known diversified company. 1) SALES DEVELOPMENT—aggressive competent man to take charge of economic evaluation, marketing, and application program of specialized plastic film product line; sales experience and research familiarity required. 2) PRODUCT DEVELOPMENT—man experienced in plastic film formulation, processing and application to integrate development program on plastic films with potential industrial uses. Reply Box 35155, Modern Plastics.

EXCELLENT OPPORTUNITY for man with experience in the extrusion and compounding of vinyl plastics. To set up and take charge of extrusion operation and compound development for established firm. Southern location. Submit resume of experience and salary requirements. Reply Box 31555, Modern Plastics.

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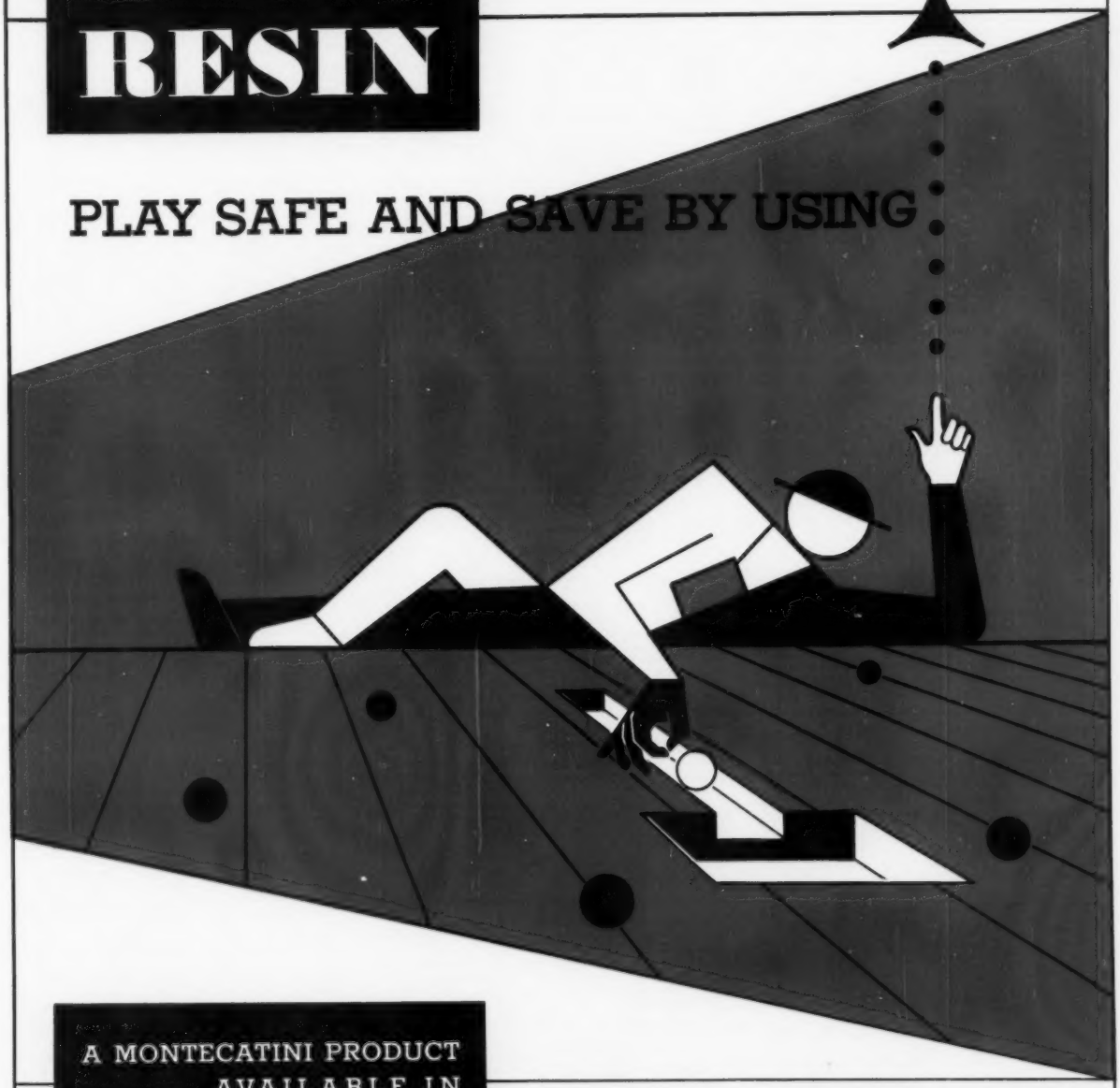

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CLASSIFIED ADVERTISING

(*Continued from page 252*)

SALES MANAGER

Progressive, successful Midwest manufacturers of specialty chemicals for the plastics industry is seeking a man to direct its sales activities. Sell through agents, later own salesmen. Must be imaginative and flexible, an executive capable of technical sales administrative planning and organizing. Experience in some branch of specialty and fine chemicals required, plastics desirable. Moderate travel, home all weekends. Desirable salary based on your qualifications, plus substantial bonus, pension plan. Please reply in detail, in complete confidence. Reply Box 33055, Modern Plastics.

COLOR TECHNOLOGIST—Man with college degree and about three years of practical experience in plastics color control. Should be familiar with methods of adding colorants, with molding equipment and with visual and instrumental color matching. Salary open. Reply Box 31455, Modern Plastics.

PRODUCTION SUPERINTENDENT: Nationally known eastern plastics material supplier has opening for production superintendent. Prefer background in thermosetting field. Must be experienced in labor relations and have necessary background to correlate and supervise plant's entire production. Work in conjunction with management, sales and planning section. This represents an unusual opportunity for the right man. Salary commensurate with experience. Please send complete work resume and photograph with first letter to Box 30755, Modern Plastics.

OPPORTUNITIES IN PLASTICS: As a large pioneer molder and extruder, we are continually expanding our processes and applications, and consequently our personnel. That means we are interested in adding qualified personnel to all departments, with or without previous experience in plastics. Write giving full details, including salary expected, to Personnel, CHICAGO MOLDED PRODUCTS CORPORATION, 1020 North Kolmar Avenue, Chicago 51, Illinois.

PLASTICS ENGINEER

Production and Development Engineer; experienced in formulation, evaluation and competitive analysis of all phases of dry blends and conventional extrusion compounds, plastisols, surface coatings, adhesives and sealers. Plant is located in Northwestern Ohio. Reply, stating age, education, experience and salary requirements. Reply Box 33655, Modern Plastics.

CHEMICAL ENGINEER: At least 5 years experience. Preferred background in phenolic resin chemistry and production. Responsibilities will include process investigations and development work. Follow up and supervise installation of new equipment working with present Engineering Dept. General trouble shooter in plant on both materials and process problems. Excellent opportunity with large eastern plastics manufacturing company. Good salary range. Please send complete resume and photograph to THE BORDEN CO., Chemical Div., Durite Plastics Dept., 5000 Summerdale Ave., Phila. 24, Pa.

CHEMIST—VINYL COATING

Require chemist experienced plastisol formulations for fabric coating operation. Good opportunity. All replies confidential. Our employees know about this ad. Reply Box 35255, Modern Plastics.

LOS ANGELES PLANT NEEDS highly experienced man for complicated vacuum and deep draw operations, on Plexiglas Royalite and Dow sheet mat. Must be thoroughly experienced with all phases of tooling and able to do some himself. Must have thorough active mechanical background. Applications will be treated very confidentially. Reply Box 34055, Modern Plastics.

WANTED: We are looking for a man experienced in plastisol and organisol types of vinyl coating to take charge of a vinyl coating plant. Address all inquiries to: ALLIED FABRIC CORP., 92 Brookline Street, East Lynn, Mass. Lynn 2-6670.

REINFORCED PLASTICS DEVELOPMENT: An engineer or chemist is required to undertake laboratory and field investigations in the practical application of glass-reinforced polyester resins. Ability to solve fabrication problems and provide technical service is a particular requirement. This is an unusual opportunity for a well-trained technical man. Send full particulars to HOOKER ELECTROCHEMICAL COMPANY, Industrial Relations Department, Box 344, Niagara Falls, New York.

VINYL CHEMIST—experienced in development work for heavy gauge calendering and conventional extrusion compounds—all replies confidential. Kindly include full details of experience, education and salary requirements. Reply Box 31255, Modern Plastics.

FLOOR TILE CHEMIST WANTED

Experienced manufacture Vinyl Tile. Good salary, liberal insurance, hospitalization and retirement. Replies will be confidential. Reply Box 32555, Modern Plastics.

PLASTIC COLORIST—Supervisor with college degree and five or more years of experience in coloring plastic materials. Intimate knowledge of colorants, of methods of incorporation and of instrumental control of color required. Familiarity with mills and extruders desirable. Supervise sizable group preparing color matches and sample orders. Salary commensurate with experience. Reply Box 31355, Modern Plastics.

VINYL CHEMIST

Experienced heavy or light gauge calendering. Good salary, liberal insurance, hospitalization and retirement. Replies treated confidentially. Reply Box 32655, Modern Plastics.

CHEMIST OR CHEMICAL ENGINEER with 3 to 7 years in Vinyl Polymer Development, Process Control, or Production Supervision. This position offers a challenge, good prospects, and security with an expanding firm, producing Plastic Resins, including Vinyl Monomer and Polymer, as well as other chemicals. Apply by mail to: NAUGATUCK CHEMICAL, Division U. S. Rubber Co., P. O. Box 460, Painesville, Ohio.

PLASTICS ENGINEER. Major packaging firm has opportunity for Plastics Engineer with mechanical engineering degree and ability to develop devices, methods and procedures in field of packaging and plastic containers and fitments. Knowledge of, and experience with, properties of plastics and chemical materials necessary. Job requires creative thinking in packaging assignments and developing new ideas and techniques. Must have ability to meet people and represent firm in customer consultant contacts. Training program provided to supplement previous experience. Reply Box 31855, Modern Plastics.

TOOL DESIGNER

With 10 to 15 years experience on plastic injection or die casting molds. Knowledge of injection molding equipment desired. Excellent opportunity with well established proprietary molder in Greater New York area. Position open as result of retirement. Please furnish complete resume and state salary desired. Reply Box 34255, Modern Plastics.

CHEMIST OR CHEMICAL ENGINEER: Midwest injection, compression, and transfer molder requires person for research and development work involving materials and products. Excellent opportunity for advancement. Send complete resume, salary expected, and recent photograph. Reply Box 30255, Modern Plastics.

POLYETHYLENE TECHNICAL SERVICE & DEVELOPMENT: The Spencer Chemical Company program of expansion and diversification continues to offer rapid advancement for men with ability and determination. Do you have a substantial background of experience in wire and cable insulation or general thermoplastics processing? Are you sufficiently versatile to deal equally well with people and equipment? Would you like to represent "America's Growing Name in Chemicals"? Please outline your education, experience, and initial salary requirements. All inquiries will receive immediate attention and will be held strictly confidential. Write: Technical Service Section, SPENCER CHEMICAL COMPANY, 610 Dwight Building, Kansas City, Mo.

PLASTICS CHIEF ENGINEER. Long established Chicago area company wants one of the best men in the industry. Experienced and know-how, specializing injection mold design, mold estimating and placement of tools, to head dept. and be responsible for all engineering. Top salary plus profit sharing bonus. Reply Box 33455, Modern Plastics.

CHEMICAL ENGINEER

. . . to help create new materials for industry. Once-in-a-lifetime opportunity for chemical engineer with Creative Ability to join a new department. Should have 2-5 years plastics compounding and processing experience. Will work closely with production facilities, research laboratories, and industrial designers to make new commercial forms of basic resins and plastics. Reply Box 33955, Modern Plastics.

ENGINEERS — SALESMEN — ADMINISTRATORS — EMPLOYERS: Confidential, rapid and professional service for nation wide placement in the Plastics field. Write giving age, education and brief experience. Employers send us job description. We will let you know how we can help you by return mail. GRAEBNER'S PLASTICS EXCHANGE "The Nation's Largest", 116 South Michigan, Room 705, Chicago 3, Illinois.

TEXAS NEEDS HELP

We have permanent opportunities galore for injection molding plant personnel—plant engineer, assistant plant superintendent, foremen, production manager, machine operators. We are proprietary molders of exciting nationally accepted new plastic housewares. In large newly equipped modern plant constantly expanding. LOMA PLASTICS, INC., P. O. Box 11277, Fort Worth, Texas.

CHIEF ENGINEER—Wanted for large well-established INJECTION MOLDING Company that also does painting and assembly; located on Long Island, N. Y. Full responsibility for all engineering, including product development, mold design, tool and product estimating, ordering and follow up of molds, development and installation of manufacturing methods. Experience in high production paint spraying helpful. Salary open. Confidential. Reply immediately, Box 30955, Modern Plastics.

SITUATIONS WANTED

AVAILABLE—Young, married man, 34, almost 10 years experience in extrusion of thermoplastics. Shift foreman 5 years, Process Engineering 1½ years. Rod, tubing, custom shapes, sheet, blown ware. Heavy experience in polyethylene film, layflat, including dry coloring, embossing, reclaiming. Desires position with advancement. New England preferred, but will consider elsewhere. Reply Box 31655, Modern Plastics.

PLASTICS ENGINEER: Extensive experience with extrusion of top quality polyethylene flat film and blown tubing plus diversified experience with extrusion of other thermoplastics. Over ten years in the plastics industry. Both production and development experience. Graduate engineer. Family. Willing to relocate for more responsible position in process or product development, production, or customer service laboratory. Reply Box 33855, Modern Plastics.

PLANT MANAGER: Broad experience in all phases of Plastics and Mechanical Rubber products. Presently employed as General Manager of Plastic extrusion and rubber company. Solid background in production, engineering, maintenance and estimating. Excellent Sales Contacts. Desires position in progressive company where proven ability will be recognized. Location is immaterial. Available on short notice. Reply Box 32855, Modern Plastics.

REINFORCED PLASTICS ENGINEER—Highly mechanical chemical engineer, age 33, experienced in all phases of reinforced plastics field, viz., new product evaluation, design, all methods of development and production. Knowledge of polyester and epoxy resins, all types of glass reinforcements, adhesives, sandwich core materials. Can design process equipment. Can set up and administer a complete organization. Reply Box 32055, Modern Plastics.

PROFESSIONAL PLASTICS CONSULTING ENGINEER desires working arrangement with firm planning expansion or entrance into reinforced plastics field. Fifteen years experience as manufacturer and consultant operating own business in Los Angeles area. Desire new contacts and engineering challenge. Varied experience in development, personnel instruction, writing, lecturing, plant set-up, management, materials evaluation and product application. Considerable experience in automobile, boat, aircraft and related industrial units with several basic processes and procedures to credit. Prefer performance contract arrangement. Will consider foreign or overseas situation. Illustrated brochure of qualifications to principals. Reply Box 32355, Modern Plastics.

EXECUTIVE SALES ENGINEER: Seasoned graduate engineer with outstanding achievement in developing and marketing new, high volume, Molded Industrial Packaging and proven sales record in Custom Injection Molded Parts. Thorough working knowledge part design, tool making and molding operations, marking and assembly. 9 years in field. Currently employed. Seeking wider opportunity. Reply Box 33755, Modern Plastics.

SALES AGENTS WANTED

SALES REPRESENTATIVES WANTED: We are looking for experienced manufacturers representatives to sell for us on a commission basis for the New York, New England and Eastern Area. Custom compression, plunger and transfer molded items are what we desire to quote on in volume. We are located in Mid-West and prefer men calling on industrial accounts. Reply Box 35655, Modern Plastics.

WANTED — MANUFACTURER'S SALES AGENT with established accounts to represent producer of embossed and sprayed plastic sheets. We have unique designs with popular appeal and are desirous of broadening our outlets in various fields. Liberal commission. All replies confidential. Reply Box 35755, Modern Plastics.

PLASTIC EXTRUDER SEEKS MANUFACTURER'S REPRESENTATIVE with following among users of plastics, preferably currently representing converter of plastic materials by other basic methods. Reply Box 32755, Modern Plastics.

CUSTOM EXTRUDER wants sales representative. We specialize in custom extrusion of vinyl shapes and have own compounding facilities. Have number of territories open. Are interested only in men of proven ability who have established contacts with industrial accounts. Commission basis. Reply Box 31055, Modern Plastics.

MANUFACTURERS REPRESENTATIVES to sell custom molded compression and injection plastic parts in several open territories including New England, New York and eastern Pennsylvania, Chicago and Mid-West area. Must be experienced with Engineering background preferred. Commission arrangement with established molder located in western Pennsylvania. We are interested particularly in men calling on industrial accounts. Reply Box 30855, Modern Plastics.

MISCELLANEOUS

IMPORTANT FRENCH CONCERN with powerful machinery equipment seeks manufacturing-licenses of rubber or plastics wide sale articles, for Shoe-Making uses. Send offers to: N°E. 3625, CONTESSE & CIE, 8 Square de la Dordogne, Paris 17, France.

TO ACT AS SALES REPRESENTATIVE in New England for manufacturer selling to plastic fabricators and extruders. Resins, fillers, pigments, plasticizers, solvents, plastic sheeting, etc. $75 weekly first 5 months. Sales reports given. Territory and commission thereafter. Limited warehousing possible. Technical background plus manufacturing and sales experience. References. Interview if practical. Reply JAMES HART, South Main Street, Andover, Mass.

INTERESTED IN PURCHASING: Dimethyl Phthalate, Diethyl Phthalate, Tricresyl Phthalate, Ortho-Nitrobiphenyl, Ethox Methox, Di Carbitol, Pycal 94. PEERLESS CHEMICAL CORP., 181 Greene Street, N.Y.C. 12.

PLASTIC INJECTION—Compression manufacturing specialist, twenty years experience in plant set up and operation, desires to join forces with reliable company using large volume of molded parts, who is interested in setting up own operation to insure delivery and reduce costs. Company that qualifies may obtain half stock interest with little capital outlay. Location northern Virginia. Have suitable building, capital. Reply Box 32455, Modern Plastics.

MANUFACTURERS REPRESENTATIVE with large industrial following in Northern Ohio desires connection with Mid-West Custom Molder. Can offer aggressive sales force with engineering know-how. Established, references. Reply Box 31155, Modern Plastics.

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Up to 60 words $10.00	Up to 120 words $20.00	Up to 180 words $30.00
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for further information address Classified Advertising Department, Modern Plastics, 575 Madison Avenue, N. Y. 22, N. Y.

MATERIAL AND PROCESS ENGINEER

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- Sealants (Fuel & Pressure Applications)

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Dept. P

North American Aviation

Columbus 16, Ohio

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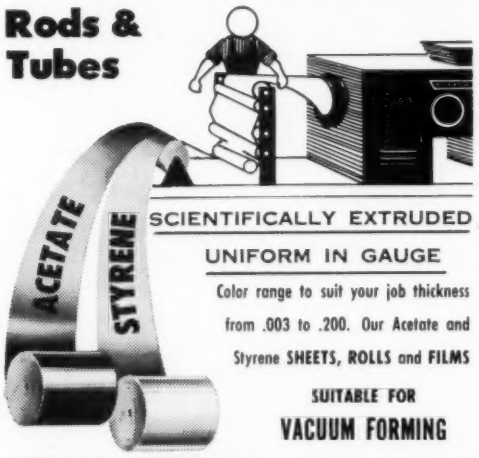

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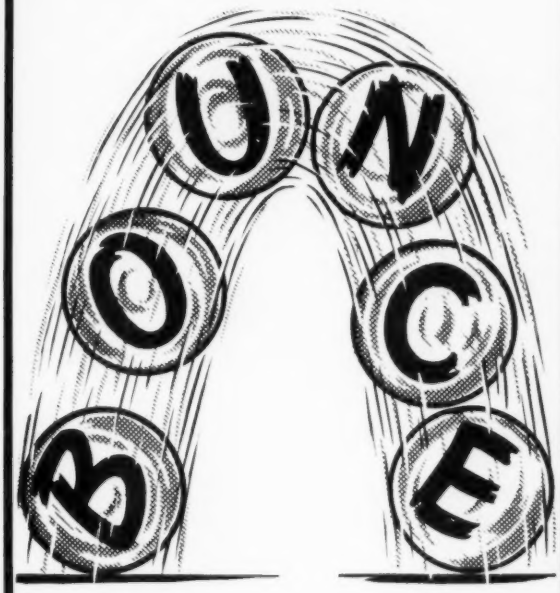

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In vinyl formulations where resilience is the primary consideration and cost of utmost importance, we recommend that you evaluate KP-220. KP-220 is a low cost plasticizer which will impart to vinyl compounds comparable resilience to the cured plastic as will much higher priced plasticizers. KP-220 far exceeds DOP in regard to resilience, with about 85% more bounce in like formulations. Actual resilience figures in our standard test with formulations containing the efficiency proportion of plasticizer show 6.1 inch of bounce for a plastic containing KP-220 to 3.7 inches for one containing DOP, and 5.4 inches for Adipol 2EH.

We manufacture other plasticizers which also impart high resilience to the finished product, but for the cost per pound of plasticizer nothing equals KP-220 in inches of bounce.

For further information, samples or technical data sheets concerning KP-220 write....

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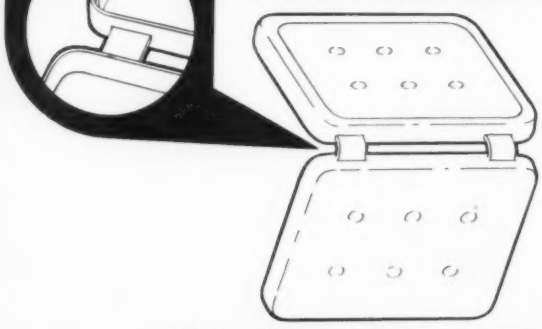

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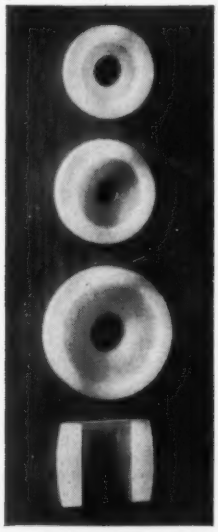

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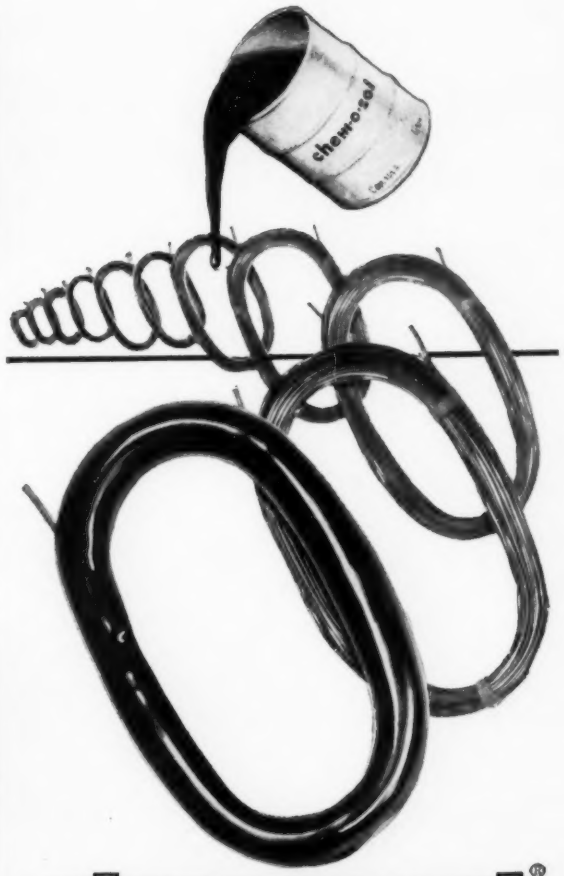

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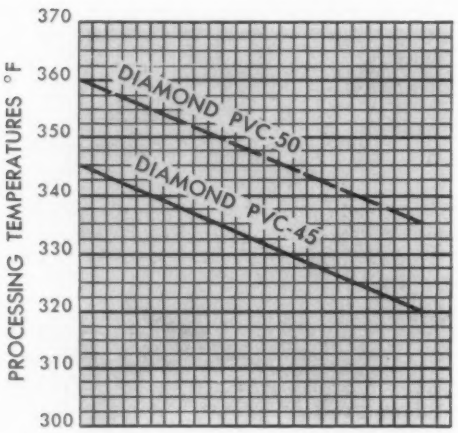

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Reference: Vol. XVIII, No. 4, October, 1954, Association of Food & Drug Officials of the United States.

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